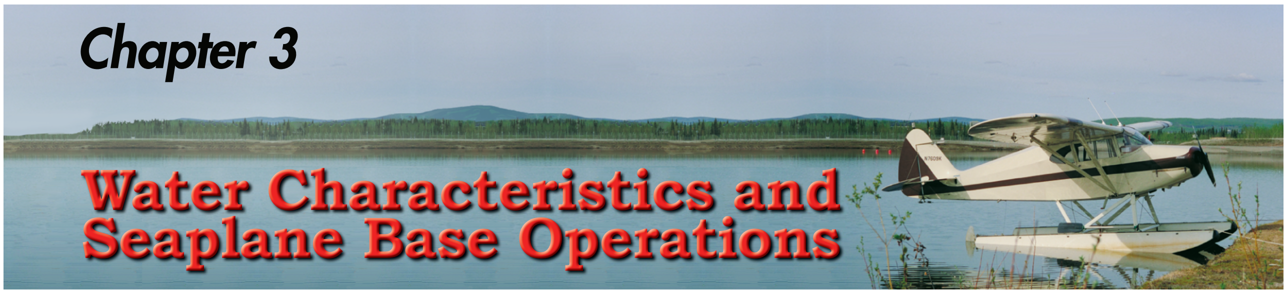
Chapter 3

Water Characteristics and Seaplane Base Operations



CHARACTERISTICS OF WATER

A competent seaplane pilot is knowledgeable in the characteristics of water and how they affect the seaplane. As a fluid, water seeks its own level, and forms a flat, glassy surface if undisturbed. Winds, currents, or objects traveling along its surface create waves and movements that change the surface characteristics.

Just as airplanes encounter resistance in the form of drag as they move through the air, seaplane hulls and floats respond to drag forces as they move through water. Drag varies proportionately to the square of speed. In other words, doubling the seaplane's speed across the water results in four times the drag force.

Forces created when operating an airplane on water are more complex than those created on land. For landplanes, friction acts at specific points where the tires meet the ground. Water forces act along the entire length of a seaplane's floats or hull. These forces vary constantly depending on the pitch attitude, the changing motion of the float or hull, and action of the waves. Because floats are mounted rigidly to the structure of the fuselage, they provide no shock absorbing function, unlike the landing gear of landplanes. While water may seem soft and yielding, damaging forces and shocks can be transmitted directly through the floats and struts to the basic structure of the airplane.

Under calm wind conditions, the smooth water surface presents a uniform appearance from above, somewhat like a mirror. This situation eliminates visual references for the pilot and can be extremely deceptive. If waves are decaying and setting up certain patterns, or if clouds are reflected from the water surface, the resulting distortions can be confusing even for experienced seaplane pilots.

DETERMINING SEA CONDITIONS

The ability to read the water's surface is an integral part of seaplane flying. The interaction of wind and water determine the surface conditions, while tides and currents affect the movement of the water itself. Features along the shore and under the water's surface contribute their effects as well. With a little study, the interplay between these factors becomes clearer.

A few simple terms describe the anatomy and characteristics of waves. The top of a wave is the **crest**, and the low valley between waves is a **trough**. The height of waves is measured from the bottom of the trough to the top of the crest. Naturally, the distance between two wave crests is the wavelength. The time interval between the passage of two successive wave crests at a fixed point is the period of the wave.

Waves are usually caused by wind moving across the surface of the water. As the air pushes the water, ripples form. These ripples become waves in strong or sustained winds; the higher the speed of the wind, or the longer the wind acts on them, the larger the waves. Waves can be caused by other factors, such as underwater earthquakes, volcanic eruptions, or tidal movement, but wind is the primary cause of most waves. [Figure 3-1 on next page]

Calm water begins to show wave motion when the wind reaches about two knots. At this windspeed, patches of ripples begin to form. If the wind stops, surface tension and gravity quickly damp the waves, and the surface returns to its flat, glassy condition. If the wind increases to four knots, the ripples become small waves, which move in the same direction as the wind and persist for some time after the wind stops blowing.

As windspeed increases above four knots, the water surface becomes covered with a complicated pattern of waves. When the wind is increasing, waves become larger and travel faster. If the wind remains at a constant speed, waves develop into a series of evenly spaced parallel crests of the same height.

In simple waves, an object floating on the surface shows that waves are primarily an up and down motion of the water, rather than the water itself moving downwind at the speed of the waves. The floating object describes a circle in the vertical plane, moving upward as the crest approaches, forward and downward as the crest passes, and backward as the trough passes. After each wave passes, the object is at almost the same place as before. The wind does cause floating objects to drift slowly downwind.

While the wind is blowing and adding energy to the water, the resulting waves are commonly referred to as wind waves or **sea**. (Sea is also occasionally used

Terms Used by U.S. Weather Service	Velocity m.p.h.	Estimating Velocities on Land	Estimating Velocities on Sea	
Calm	Less than 1	Smoke rises vertically.	Sea like a mirror.	Check your glassy water technique before water flying under these conditions.
Light Air	1 - 3	Smoke drifts; wind vanes unmoved.	Ripples with the appearance of scales are formed but without foam crests.	
Light Breeze	4 - 7	Wind felt on face; leaves rustle; ordinary vane moves by wind.	Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break.	
Gentle Breeze	8 - 12	Leaves and small twigs in constant motion; wind extends light flag.	Large wavelets; crests begin to break. Foam of glassy appearance. (Perhaps scattered whitecaps.)	Ideal water flying characteristics in protected water.
Moderate Breeze	13 - 18	Dust and loose paper raised; small branches are moved.	Small waves, becoming longer; fairly frequent whitecaps.	
Fresh Breeze	19 - 24	Small trees begin to sway; crested wavelets form in inland water.	Moderate waves; taking a more pronounced long form; many whitecaps are formed. (Chance of some spray.)	This is considered rough water for seaplanes and small amphibians, especially in open water.
Strong Breeze	25-31	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.	Large waves begin to form; white foam crests are more extensive everywhere. (Probably some spray.)	
Moderate Gale	32-38	Whole trees in motion; inconvenience felt in walking against the wind.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	This type of water condition is for emergency only in small aircraft in inland waters and for the expert pilot.

Figure 3-1. The size of waves is determined by the speed of the wind.

to describe the combined motion of all the factors disturbing the surface.) These waves tend to be a chaotic mix of heights, periods, and wavelengths. Because the wind causes the height to increase faster than the wavelength, they often have relatively steep, pointed crests and rounded troughs. With a windspeed of 12 knots, the waves begin to break at their crests and create foam.

The height of waves depends on three factors: windspeed, length of time the wind blows over the water, and the distance over which the wind acts on the water. As waves move away from the area where they were generated (called a **fetch**), they begin to sort themselves by height and period, becoming regular and evenly spaced. These waves often continue for thousands of miles from where they were generated. **Swell** is the term describing waves that persist outside the fetch or in the absence of the force that generated them. A swell may be large or small, and does not indicate the direction of the wind. The wake of a boat or ship is also a swell.

Unlike wind and current, waves are not deflected much by the rotation of the Earth, but move in the direction in which the generating wind blows. When this wind ceases, water friction and spreading reduce the wave height, but the reduction takes place so slowly that a swell persists until the waves encounter an obstruction, such as a shore. Swell systems from many different directions, even from different parts of the world, may cross each other and interact. Often two or more swell systems are visible on the surface, with a sea wave system developing due to the current wind.

In lakes and sheltered waters, it is often easy to tell wind direction by simply looking at the water's surface. There is usually a strip of calm water along the upwind shore of a lake. Waves are perpendicular to the wind direction. Windspeeds above approximately eight knots leave wind streaks on the water, which are parallel to the wind.

Land masses sculpt and channel the air as it moves over them, changing the wind direction and speed. Wind direction may change dramatically from one part of a lake or bay to another, and may even blow in opposite directions within a surprisingly short distance. Always pay attention to the various wind indicators in the area, especially when setting up for takeoff or landing.

While waves are simply an up and down undulation of the water surface, **currents** are horizontal movements of the water itself, such as the flow of water downstream in a river. Currents also exist in the oceans, where solar heating, the Earth's rotation, and tidal forces cause the ocean water to circulate.

WATER EFFECTS ON OPERATIONS

Compared to operations from typical hard-surface runways, taking off from and landing on water presents several added variables for the pilot to consider. Waves and swell not only create a rough or uneven surface, they also move, and their movement must be considered in addition to the wind direction. Likewise, currents create a situation in which the surface itself is actually moving. The pilot may decide to take off or land with or against the current, depending on the wind, the speed of the current, and the proximity of riverbanks or other obstructions.

While a landplane pilot can rely on windsocks and indicators adjacent to the runway, a seaplane pilot needs to be able to read wind direction and speed from the water itself. On the other hand, the landplane pilot may be restricted to operating in a certain direction because of the orientation of the runway, while the seaplane pilot can usually choose a takeoff or landing direction directly into the wind.

Even relatively small waves and swell can complicate seaplane operations. Takeoffs on rough water can subject the floats to hard pounding as they strike consecutive wave crests. Operating on the surface in rough conditions exposes the seaplane to forces that can potentially cause damage or, in some cases, overturn the seaplane. When a swell is not aligned with the wind, the pilot must weigh the dangers posed by the swell against limited crosswind capability, as well as pilot experience.

On the other hand, calm, glassy water presents a different set of challenges. Since the wind is calm, taxiing and docking are somewhat easier, but takeoffs and landings require special techniques. Takeoff distances may be longer because the wings get no extra lifting help from the wind. The floats seem to adhere more tenaciously to the glassy water surface. When landing, the flat, featureless surface makes it far more difficult to gauge altitude accurately, and reflections can create confusing optical illusions. The specific techniques for glassy water operations are covered in Chapter 4, Seaplane Operations–Preflight and Takeoffs, and Chapter 6, Seaplane Operations–Landing.

Tides are cause for concern when the airplane is beached or moored in shallow water. A rising tide can lift a beached seaplane and allow it to float out to sea if the airplane is not properly secured. Depending on the height of the tide and the topography of the beach, an outgoing tide could leave a beached seaplane stranded far from the water. [Figure 3-2]

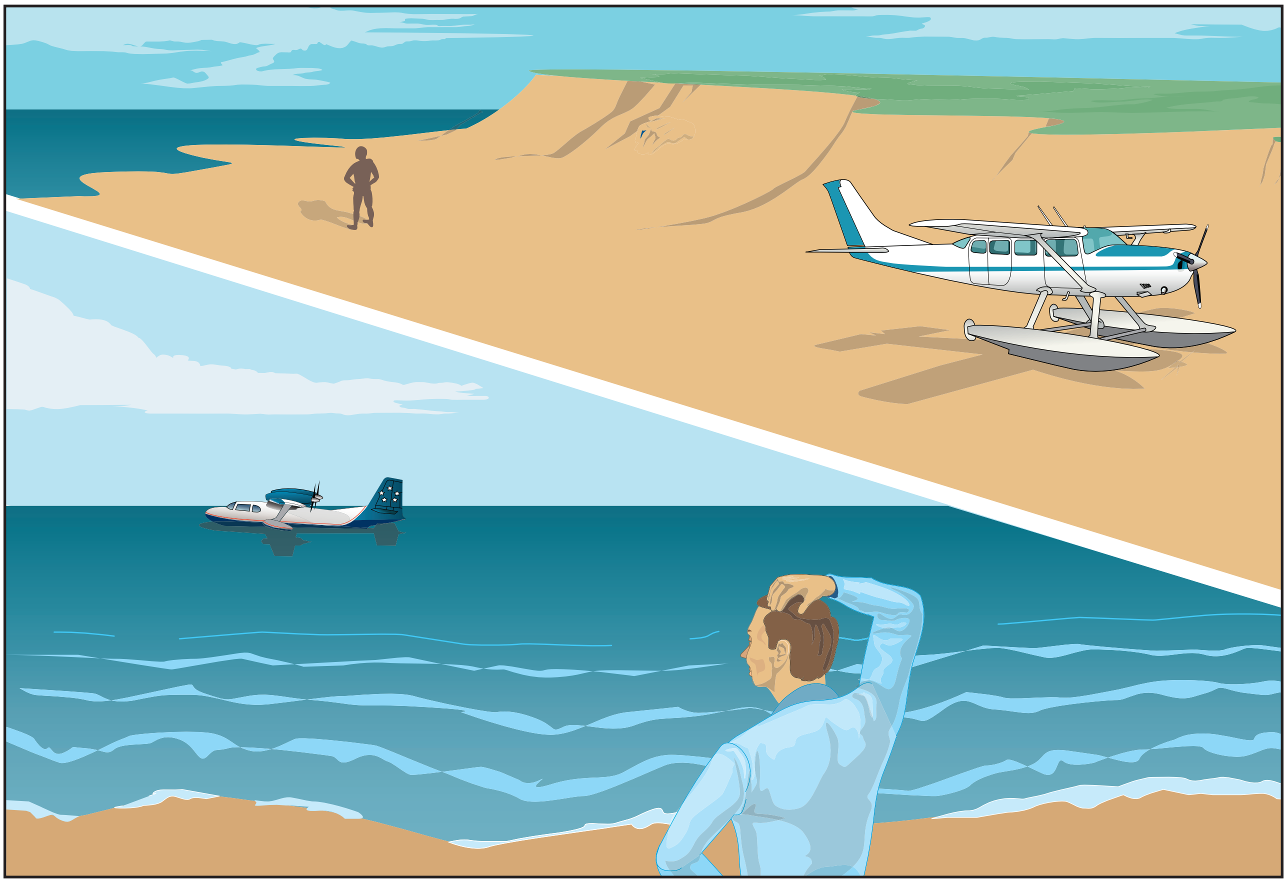


Figure 3-2. An outgoing tide can leave a seaplane far from the water. A rising tide can cause a beached seaplane to float away.

Many of the operational differences between landplanes and seaplanes relate to the fact that seaplanes have no brakes. From the time a seaplane casts off, it is usually in continuous motion due to the wind and current, so the pilot must take deliberate action to control this movement. Often these forces can be used to the pilot's advantage to help move the seaplane as desired. Starting the engine, performing the engine runup, and completing most pre-takeoff checks are all accomplished while the seaplane is in motion. The seaplane continues moving after the engine is shut down, and this energy, along with the forces of wind and current, is typically used to coast the seaplane to the desired docking point.

As with land airplanes, the wind tends to make the airplane weathervane, or yaw, until the nose points into the wind. This tendency is usually negligible on landplanes with tricycle landing gear, more pronounced on those with conventional (tailwheel) gear, and very evident in seaplanes. The tendency to weathervane can usually be controlled by using the water rudders while taxiing, but the water rudders are typically retracted prior to takeoff. Weathervaning can create challenges in crosswind takeoffs and landings, as well as in docking or maneuvering in close quarters.

SEAPLANE BASE OPERATIONS

In the United States, rules governing where seaplanes may take off and land are generally left to state and local governments.

Some states and cities are very liberal in the laws regarding the operation of seaplanes on their lakes and waterways, while other states and cities may impose stringent restrictions. The Seaplane Pilots Association publishes the useful Water Landing Directory with information on seaplane facilities, landing areas, waterway use regulations, and local restrictions throughout the United States. Before operating a seaplane on public waters, contact the Parks and Wildlife Department of the state, the State Aeronautics Department, or other authorities to determine the local requirements. In any case, seaplane pilots should always avoid creating a nuisance in any area, particularly in congested marine areas or near swimming or boating facilities.

Established seaplane bases are shown on aeronautical charts and are listed in the Airport/Facility Directory. The facilities at seaplane bases vary greatly, but most include a hard surface ramp for launching, servicing facilities, and an area for mooring or hangaring seaplanes. Many marinas designed for boats also provide seaplane facilities.

Seaplanes often operate in areas with extensive recreational or commercial water traffic. The movements of faster craft, such as speedboats and jet-skis are unpredictable. People towing skiers may be focusing their attention behind the boat and fail to notice a landing seaplane. Swimmers may be nearly invisible, often with just their heads showing among the waves. There is no equivalent of the airport traffic pattern to govern boat traffic, and although right-of-way rules exist on the water, many watercraft operators are unaware of the limits of seaplane maneuverability and may assume that seaplanes will always be able to maneuver to avoid them. Many times, the seaplane itself is an object of curiosity, drawing water traffic in the form of interested onlookers.

When seaplane operations are conducted in bush country, regular or emergency facilities are often limited or nonexistent. The terrain and waterways are frequently hazardous, and any servicing becomes the individual pilot's responsibility. Prior to operating in an unfamiliar area away from established seaplane facilities, obtain the advice of FAA Accident Prevention Counselors or experienced seaplane pilots who are familiar with the area.