Research

### Tide pool functionality: the mechanics and the variables

Tide pools have long been considered fascinating many people due to their unique, interdependant ecosystem. They have been called a "Darwin Free-for-all," where every species is dependant upon another for either food, shelter, or some other necessity.

These wonderous pools occur in what is commonly referred to as the intertidal region, that being the area in between where high and low tides occur. As the tide lowers, water is left in puddles between rocks and crevices, often where small oceanic organisms dwell. Only when the tides reach this level can man witness up close the living laboratories that are tide pools.

A unique trait that tide pools boast over most earthly environments (with the exception of the rainforsts) is their staggering number of species. A large tide pool can contain as many as 600 different species of plants and animals- the majority of which is just varieties of algae. These organisms, initially appearing to be delicate and extremely vulnerable to the fury of the ocean, are in reality capable of withstanding crashing waves that create a force up to 30 times the weight of a human!

Although these organisms are capable of withstanding such harsh environmental conditions, there are factors that are essential to their survival. The two that probably have the most impact are the temperature and salinity of the water. Without the correct balance of either, death would result rather quickly.

The typical water temperature of a tide pool ecosystem in the area studied is approximately 9�-11� C. This temperature reflects the annual average temperature in the San Fransisco Bay Area; slight fluxuations are expected. Temperature is a critical factor in the existence of any organisms. Virtually all bodily processes are affected by changes in temperature. Metabolic processes may shut down as temperatures rise, due to the denaturing of enzymes (proteins) necessary to carry out specific processes. Conversely, if temperatures fall too low, these enzymes may become too rigid, thus inhibiting the ability of their active site to accomidate their appropriate substrates.

Temperature is mostly affected by the nature of tide pools. Those pools that are higher in the intertidal region are more likely to become isolated and inaccessable to fresh sea water- which is both cool and rich in oxygen. If such a pool becomes isolated for an extensive period of time, the water will slowly be heated to a temperature that may cause organisms to become in danger or die. Tide pools have even been known to reach temperatures in excess of 100� F, a temperature fatal to most oceanic life.

This endangering of tide pool life is not all attributed to the heat alone. The amount of oxygen present in the water is just as responsible for this phenomenon. As more sunlight penetrates the water, it induces the seaweed in the tide pool to manufacture oxygen as a result of photosynthesis. As the temperature increases as well, however, much of the oxygen is released into the air as a gas, which eventually causes an enormous drop off in the oxygen concentration within the tide pool. Organisms dependant upon oxygen thus begin attempting to bring it in more rapidly, and can eventually suffocate. It is the ocean's life-giving properties that give a tide pool its resources necessary for survival. Without its touch for more than a few hours, the entire microcosm becomes in danger of death.

Just as important as temperature in a tide pool ecosystem is the the salinity, or salt concentration of the water. This is also directly affected to the temperature of the pool; as the temperature increases, more and more water evaporates into the air leaving behind a solution that is increasingly salty. A normal level of salt is critical for the survival of all tide pool organisms. This normal level is on average a quarter pound of salt per gallon of seawater, although this varies from region to region. At this level, the organisms are within an appropriate osmotic pressure with their environment. If too much evaporation occurs (or there is too much salt in the water), the cells of the organisms are in a hypertonic environment in which they need to release water to compensate for the new osmotic pressure. On the other hand, if too much rainwater, for example, enters the pool, the cells would be in an hypotonic solution in which they would swell. Both conditions could result in the organism's death if the levels reach an extreme. This is, once again, avoidable if a balance can be made by the introduction of fresh ocean water into the tide pool, thus creating the favorable isotonic solution that is favored by all organisms.

The recent presense of El Ni�o along the Pacific coast has the potential of disturbing all of the above stated. With warmer waters, producing more rain, it threatens to disrupt the ecological balance that occurs in tide pools. The increasing temperature have already been determined, by researchers, to cause fish to be driven from their normal grounds, thus upsetting the entire region's dependency upon this link in the food chain. It is predicted that the number of starved seals and otters will double due to this disruption. More specifically to the tide pools, there are expected to be decreases in the kelp, shellfish, and sea star population along the coast.

### Organisms

There are several species of plants and animals typically found in local tide pools that have researched as an initial step to observing them. These organisms are all found within the Moss Beach Wildlife Preserve located just north of Half Moon Bay, California, where the following experiment was conducted. All, with the exception of one sea star (the Bat Star), were found within the specific tide pool I studied. Below is a overhead view of the entire pool studied, approximately six feet in length.

The letters A-D represent the approximate locations of the organisms described below. It should be noted that the organism studied were only a small percentage of the total life that exists within any given tide pool. These organisms were choicen primarily due to their accessability and easy identification.

#### **A**

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|  | The Ochre Sea Star is by far the most common large sea star within its range. This organism can be found from Alaska to Baja California, where it inhabits the wave-washed rocky shores well within the intertidal zone. This Ochre, presumably a young one judging from its size, inhabited the eastern side of the observed tide pool, where it lay on top of the surrounding mussels, its common prey. |

#### **B**

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| The Giant Green Sea Anemone is by far the largest and most abundant of all higher tide pool organisms. This primative animal is usually 12" in length and 10" wide. It is typically found within tide pools connected rocky surfaces. The anemone captures its prey by stinging it with a neural poison and then consuming it through its stomach (located down the center of the body). This sting is harmless to any but nearly microscopic organisms. |  |

The pink plant found surrounding the Green Anemone, and throughout the pool, is Red Coralline Algae. This algae is commonly found in lower tidal regions, reaching its highest abundance in the subtidal zone. The algae is a common home for small fish (none found in this pool), snails, and hermit crabs.

#### **C**

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|  | The shells in the picture to the left are of the Black Tegula, or Black Turban, snail. These particular types of shells are found abundantly off the west coast, from British Columbia to Baja. The tide pool I analyzed had many of this variety, most of which were uninhabited. The other organism shown, the Grainy Hermit Crab, is also fairly common to the region. According to resources, it is particularly fond of the Black Turban shell as a home, which would explain the why numbers of both were found in area C of the research tide pool. |

#### **D**

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| The California Mussel, indigenous from Alaska to Baja California, is found in large quantities in area D. They grow off of the rocks surrounding and submerged in the tide pool; they thus become the prey of many tide pool organisms, particularly sea stars. In addition to being consumed by aquatic predators, these mussels are often harvested for consumption by humans. |  |

The small barnacle seen in the lower right-hand corner is known as the Little Striped Barnacle. Although within its range, the Striped Barnacle is more common to warmer waters along Southern California and Central America. This species requires a water temperature of at least 20� C to breed.

Although well adapted to their environments, it remains to be seen whether or not El Ni�o will cause a change in the number of these organisms found. Warmer waters, as previously described, have the potential to cause many changes in a typical tide pool's ecosystem- including salinity and the increased possibility of desiccation due to excessive evaporation. It is hoped that this experiment will provide some evidence to either prove or disprove this possibility.

\*All photos taken by Brian Wikner via the Olympus D-300L Digital Camera