PART ONE OF TWO

BEACH SAND AT THE BASE OF THE FOOD CHAIN

by Peter Etnoyer, Chad Nelsen, and Kevin Ranker

The Surfrider Foundation is concerned that the majority of marine conservation efforts stop at the water's edge, when it is the beach that forms the foundation of a national pastime, and it is the beach that bears the brunt of development pressure. While the economic benefits of beaches are well documented ($14 billion in direct revenue to California in 1998) and a majority of coastal residents use and enjoy the beach frequently (despite the chilly waters, 80 percent of Washington residents go to the beach at least several times a year), the ecological contributions of sandy beach habitat and its associated shallows are less documented. It is the intention of this paper to demonstrate trophic linkages that "climb the ladder" from the intertidal all the way up to the killer whale (Orcinus orca) in the Pacific Northwest and the Atlantic bluefin tuna (Thunnus thynnus) in the Gulf of Maine. It is also our intention to review those species with beach obligate life histories. We hope that identifying these links will help to alleviate some of the development pressures placed upon intertidal ecosystems by misguided management practices, namely, shoreline armoring, relic dams,and beach "renourishment."

Trophic linkages or food webs describe what eats what. In other words, they describe how species are dependent on other species for their sources of food and they connect species at the "base" of the food chain to "apex" predators. A typical example of a marine food web is phytoplankton (a primary producer that makes food from photosynthesis) that gets eaten by zooplankton (for example copepods that are herbivorous), which in turn is eaten by planktivorous fish such as anchovies, which in turn get eaten by picscivorous fish such as mackerel. This food web describes the trophic linkage or dependency between mackerel and phytoplankton. Therefore, reductions in phytoplankton eventually affect mackerel.

Beach sand – a taste of coastal geology

The beach is like an iceberg, in that the vast majority of a beach's volume lies beneath the surface of the waves. We walk, surf, and build upon a sandy accumulation that represents only the very tip of this iceberg. Coastal geologists know this as a "littoral cell," a semi-closed system of shifting sediment driven by topography and by currents. Longshore currents drive sediments down current in a phenomenon known as "littoral drift." Most of the West Coast has a very high rate of littoral drift. In California for instance, the littoral drift transports several hundreds of thousands to many hundreds of thousands of cubic yards of sediment per year. At 300,000 cubic yards per year, this is equivalent to a 10-yard dump truck, every 17 minutes, 24 hours a day, 365 days per year to replace natural sediment inputs.

Beach sand starts in the mountains and in the bluffs adjacent to the beach. When you block the river flow with a dam, or divert it with a development, you cut off a beach's upstream supply. When you build a seawall, you cut off the beach's ground supply. Renourishment, shoreline armoring, and relic dams are cumulative problems. Individual projects can occur at the municipal level where they are poorly regulated, or poorly managed. The sum total of these activities can quickly lead to a situation where a state finds that 35% of its naturally occurring shoreline has been armored and 50% of its natural rivers have been dammed. In California, shoreline armoring increased from about 26 miles to 130 miles from 1971 to 1990, a 500% increase in beach destroying seawalls and in Washington's Puget Sound over 30% of the shoreline is armored; this includes a segment between Everett and Tacoma that is more than 95% armored. Logically, we can then expect a proportionate decrease in species abundance for those species dependent upon the shallow intertidal.

Species depend upon sand

The results of seawall construction are well documented. ; The immediate impact of these hardened structures is a dramatic alteration of the beach profile. Waves that once dissipated evenly along a gradual slope now rebound with a concentrated dissipation of energy at the base of the seawall. This causes increased erosion and scouring of the sand at the base, suspending these sediments, and eliminating the shallow water. Shallow water is host to two habitats that act as refuge to juvenile fishes, the "baby pool" of ankle deep waters too shallow for predators and "the forest" of nearshore vegetation.

The "baby pool" is obvious to anyone who has rolled up his or her pants and strolled along the waters edge. Schools of "minnows" might actually be any number of coastal species that seek refuge in the shallowest three inches of calm water that deny access to larger fishes. Coral reef fish larvae on the island of Moorea are known to aggregate in wave crests on or around the night of the new moon. In this darkness, they ride the crests of waves over the heads of predators, and into the safety of the shallows.

With the recent listing of many salmon stocks as threatened or endangered, the issue of maintaining salmon forage fish stocks has been identified by the Washington Department of Fish and Wildlife as a high priority. All the important forage fishes, i.e. herring, grunion, sand lance and surf smelt, depend on nearshore habitats for spawning and rearing. Protection of nearshore habitats utilized as spawning and rearing areas for forage fishes will be needed if salmon recovery is to be successful.

Recommendations:

- *Outlaw seawall construction*
- *Remove relic seawalls to restore natural sediment flows*

Grunion (Leuresthes tenuis) are members of the silverside family, Atherinidae. They normally occur from Point Conception, California, to Point Abreojos, Baja California. They inhabit the nearshore waters from the surf to a depth of 60 feet, and serve as a source of food to many fishes and mammals, including the bottlenose dolphin (Tursiops truncates). Grunion are an example of forage fish, the fish that other fishes eat, and they depend upon beach sand to lay their eggs. Grunion leave the water at night to spawn on the beach in the spring and summer months two to six nights after the full and new moons. Spawning begins after high tide and continues for several hours. As a wave breaks on the beach, grunion swim as far up the beach slope as possible. The female digs a nest by arching her back in the semi-liquid sand and the male grunion fertilizes the eggs externally. Mature females lay between 1,600 and 3,600 eggs during one spawn, with the larger females producing more eggs.

Similar studies identify surf smelt, sand lance, and herring as a major prey item of salmon, which in turn constitute 90% of the diet of the southern resident killer whale populations. Trophic linkages are essential to a proper understanding of the population dynamics of endangered and commercially valuable species, but the pieces of the puzzle are only now coming together. Stomach content studies are rare. This field of analysis is underfunded. But we would not know the coastal fox depends upon the beach without finding hundreds of “beach hoppers” in their stomach.

Recommendations:

- *Identify trophic linkages for beach obligate species*
- *Remove relic dams as part of a National Restoration Program*

Processes that deplete sand – shoreline armoring

Shoreline armoring includes bulkheads, seawalls, riprap, groins, jetties, and geotubes. While bulkheads, seawalls, riprap, and geotubes are intended to protect private property from the encroaching sea, groins and jetties are intended to slow or contain littoral drift. Rising sea levels (10-25cm in the last 100 years) are certain to exacerbate shoreline armoring problems in the future, but unlikely to resolve private property issues in a cost effective manner.

This illustration, taken from a poster commissioned by Friends of the San Juans, depicts the connection between the eelgrass, herring, salmon, orca and humans in the nearshore marine ecosystem. Source: Jennifer L. Rigg

The loss of beach habitat from the Matilija Dam in California represents a direct loss in spawning habitat for grunion, which compose the diet of coastal bottlenose dolphins. In the Pacific Northwest and the Gulf of Maine, sand lance (Ammodytes hexapterus) fill a similar ecological niche. Sand lance deposit eggs on a rather broad range of beach surface substrates,although most spawning appears to occur on finer grained sand. Spawning occurs at tidal elevations ranging from +5 feet to about the mean higher high water line. After deposition,sand lance eggs may be scattered over a wider range of the intertidal zone by wave action. The incubation period is about four weeks.

Bluefin tuna arrive in the Gulf of Maine around late May of every year to feed on seasonal aggregations of prey species such as herring, mackerel and sand lance. Stomach content studies indicate that sand lance are a major prey item for this valuable species in the Northeast.

The use of bulkheads and rock walls is a particularly difficult issue for coastal managers because the effects of these seawalls are counter-intuitive. Bulkheads and rock walls can reduce erosion caused by wave action, but they may do little to prevent continued erosion and sliding of the upper bank. Bulkheads will not prevent the beach itself from eroding. In fact, bulkheads can exacerbate beach erosion and erode nearby beaches. The mean beach width along armored shorelines in Hawaii is roughly the mean beach width adjacent to unarmored, freely migrating shorelines. Bluffs and cliffs that stood waiting to provide new sediment to the beach are now locked behind unforgiving walls.

NEXT ISSUE: PART TWO Processes that add sand.