From Flash Fiction to Instant Ecology Exercises Steinbeck institute 2018

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There are instances in the classroom when science students would benefit from analysis of a literary excerpt with a scientific slant. This project will identify multiple passages from the books of John Steinbeck to help science teachers deliver their own version of *Flash Fiction to their students. (see the end of this document to learn more about Flash Fiction)

I call this practice - Instant Ecology Exercises.

Why John Steinbeck? While he is known as a literary lion, having been awarded the Nobel Prize in Literature in 1962, Steinbeck also wrote deeply about biology and the burgeoning field of ecology. Numerous Steinbeck novels and his travelogue of a scientific expedition entitled The Log of The Sea of Cortez provide vivid passages for exploration for students in science classrooms. This approach can serve multiple goals for teachers and enrich a student's skill acquisition in a wide range of areas.

Here is an incomplete listing of the value of incorporating Steinbeck into science classes.

A. Students are exposed to rich and detailed writing based upon authentic field observations. This exposure can improve their own writing, a skill that can be cultivated through the keeping of a naturalist notebook.
B. Students are exposed to the desirability, in fact necessity, of using all their senses in observing nature. This exposure can improve their own observations.
C. Students learn valuable insights about taking field observations – for example: "Go low and go slow." Nature will reveal itself if given the time to do so! Be patient.
D. These passages reveal the primacy of many ecological principles without naming the principle – this allows students the opportunity to analyze a passage and to bring their own insights, vocabulary, and understanding to it.
E. Steinbeck asks "essential questions." These questions are great for discussion and in seeking written responses from students.
F. Steinbeck explores the relationships between humans and their environment, placing humans as a part of, not a part from, the natural world.
G. Steinbeck's relationship with pioneering marine biologist Ed Ricketts presents students with an example of a wonderful synergy between disparate intellects who, together, fused a legacy of thought and insight and literature that never would have been achieved separately.
H. Steinbeck looks at science not as a "high priesthood" of authority – but as a never-ending quest to get closer to the secrets and lessons nature can bestow on us if we are humble and clever enough to seek the truth, as best we can, given our own limitations.

What follows are ten excerpts from Steinbeck's books including, Cannery Row, The Grapes of Wrath, and The Log of the Sea of Cortez. I have also included possible exercises or discussion questions to be paired with each passage for consideration.

Table of Quotes and related Ecological Topics:

Passage from Chapter 1 in The Grapes of Wrath
Topic: The Dust Bowl – drought, desertification, and poor farming practices

Passage from Chapter 3 in The Grapes of Wrath
Topics: Seed adaptations and dispersal mechanisms

Passage from Chapter 6 in Cannery Row
Topics: biodiversity, trophic levels, food chains, food webs, camouflage, reproductive strategies – R & K-select, zonation in the inter-tidal region, the "tidal clock"

Passage from Chapter 13 in Cannery Row
Topics: annual and circadian rhythms, animal behavior, microclimates

Passage from Chapter 17 in Cannery Row
Topics: habitat, life-cycle of a species, community of species

Passage from Chapter 8 in The Log of the Sea of Cortez
Topics: resilience, competition for space as a limiting factor, conditions vs resources, population density, invertebrate biodiversity, taxonomic classification

Passage from Chapter 10 in The Log of the Sea of Cortez
Topics: why science "matters" – a basis for good decision-making

Passage from Chapter 25 in The Log of the Sea of Cortez
Topics: animal behavior – schooling or "collective intelligence", the "superorganism" concept

Passage from Chapter 27 in The Log of the Sea of Cortez
Topics: overharvesting, habitat destruction, food web collapse, the "commons", sustainable fishing, the need for good science to inform our exploitation of natural resources sustainably

Passage from Chapter 28 in The Log of the Sea of Cortez
Topics: decomposition, turning wastes into raw materials to be recycled for the next generation of life, biogeochemical cycles, the "superorganism concept," the Gaia Hypothesis

From The Grapes of Wrath - Chapter 1

To the red country and part of the gray country of Oklahoma, the last rains came gently, and they did not cut the scarred earth. The plows crossed and recrossed the rivulet marks. The last rains lifted the corn quickly and scattered weed colonies and the grass along the sides of the road so that the gray country and the dark red country began to disappear under a green cover. In the last part of May the sky grew pale and the clouds that had hung in high puffs for so long in the spring were dissipated. The sun flared down on the growing corn day after day until a line of brown spread along the edge of each green bayonet. The clouds appeared, and went away, and in a while they did not try anymore. The weeds grew darker green to protect themselves, and they did not spread anymore. The surface of the earth crusted, a thin hard crust, and as the sky became pale, so the earth became pale, pink in the red country and white in the gray country.

In the water –cut gullies the earth dusted down in dry little streams. Gophers and ant lions started small avalanches. And as the sharp sun struck day after day, the leaves of the young corn became less stiff and erect; they bent in a curve at first, and then, as the central ribs of strength grew weak, each lift tilted downward. Then it was June, and the sun shone more fiercely. The brown lines on the corn leaves widened and moved in on the central ribs. The weeds frayed and edged back toward their roots. The air was thin and the sky more pale; and every day the earth paled.

In the roads where the teams moved, where the wheels milled the ground and the hooves of the horses beat the ground, the dirt crust broke and the dust formed. Every moving thing lifted the dust into air: a walking man lifted a thin layer as high as his waist, and a wagon lifted the dust as high as the fence tops, and an automobile boiled a cloud behind it. The dust was long in settling back again.

When June was half gone, the clouds moved up out of Texas and the Gulf, high heavy clouds, rain-heads. The men in the fields looked up at the clouds and sniffed at them and held wet fingers up to sense the wind. And the horses were nervous while the clouds were up. The rain-heads dropped a little spattering and hurried on to some other country. Behind them the sky was pale again and the sun flared. In the dust there were drop craters where the rain had fallen, and there were clean splashes on the corn, and that was all.

A gentle wind followed the rain clouds, driving them on northward, a wind that softly clashed the drying corn. A day went by and the wind increased, steady, unbroken by gusts. The dust from the road fluffed up and spread out and fell on the weeds beside the field, and fell into the fields a little way. Now the wind grew strong and hard and it worked at the rain crust in the corn fields. Little by little the sky was darkened by the mixing dust, and the wind felt over the earth, loosened the dust, and carried it away. The wind grew stronger. The rain crust broke and the dust lifted up out of the fields and drove gray plumes into the air like sluggish smoke. The corn threshed the wind and made a dry, rushing sound. The finest dust did not settle back to earth now, but disappeared into the darkening sky.

The wind grew stronger, whisked under stones, carried up straws and old leaves, and even little clods, marking its course as it sailed across the fields. The air and the sky darkened and through them the sun shone redly, and there was a raw sting in the air. During the night the wind raced faster over the land, dug cunningly among the rootlets of corn, and the corn fought the wind with its weakened leaves until the roots were freed by the prying wind and the each stalk settled wearily sideways toward the earth and pointed the direction of the wind.

The dawn came, but no day. In the gray sky the red sun appeared, a dim red circle that gave a little light, like dusk; and as that advanced, the dusk slipped back toward darkness, and the wind cried and whimpered over the fallen corn.

Men and women huddled in their houses, and they tied handkerchiefs over their noses when they went out, and wore goggles to protect their eyes.

This is, of course, Steinbeck introducing the reader to the historical ecological disaster we know today as the Dust Bowl. Students may know very little about this period in American history such that a very simple set of questions may help to probe their understanding of the passage at first.

What is happening in chapter one?
What is happening to plant life? How is this revealed in the passage?
What is happening to the land and soil? How is this revealed in the passage?
What is happening to the people? How is this revealed in the passage?
What are possible explanations for this traumatic situation?
Does anyone know what historical event Chapter One is describing?
What elements of the writing stand out to you?
Is there any "word choice" you find unusual or notable from the author? Why do you think the author chose that/those words?

A PowerPoint showing images from the Dust Bowl era can be very powerful approach in revealing the magnitude of this disaster. Photos from Dorothea Lange also help to illustrate the human toll. Certainly, this can elicit a discussion of not only the climate factors associated with drought conditions but also the human factors such as unsustainable farming practices that contributed to this disaster and the displacement of as many as 2.5 million American citizens. An expanded discussion could describe the biome that was the grasslands of the Great Plains, its formation through co-evolution with the American bison, the concept of a rain shadow, current issues with farming in this region as it relates to the depletion of the Ogallala Aquifer, and the specter of another dust bowl in the future as climate change occurs. The History Channel has an excellent article online as a starting place.
https://www.history.com/topics/dust-bowl

From The Grapes of Wrath – Chapter 3

The concrete highway was edged with a mat of tangled, broken, dry grass, and the grass heads were heavy with oat beards to catch on a dog's coat, and the foxtails to a tangle in a horse's fetlocks, and clover burrs to fasten in a sheep's wool; sleeping life waiting to be spread and dispersed, every seed armed with an appliance of dispersal, twisting darts and parachutes for the wind, little spears and balls of tiny thorns, and all waiting for animals and the wind, for a man's trouser cuff or the hem of a woman's skirt, all passive but armed with appliances of activity, still, but each possessed with the anlage of movement.

In terms of an activity, I would provide students the passage and give them 5 minutes to read and reread it and think about the ecological insights the passage provides. I would provide students a prepared handout or ask them to make a grid with three columns. Column number one could be the passage itself. Column two would be the place to record direct observations or quotes from the excerpt. Column number three would be the student's analysis of what ecological or scientific principles the author is alluding to in the passage.

I would ask students to share their insights and make a list on the board. For this passage, these would likely include aspects of plant evolution as this is the basis for all of the variation described for seeds. Column two would include the descriptive seed adaptations. And column three would likely include the various methods of seed dispersal taken up over time by living things. This could engender a conversation as to why seed dispersal is necessary at all – why do plants send out so many seeds in all directions in such a variety of ways? What advantages are there when your species is widely spread vs occupying a small area? A discussion of the concept of co-evolution might ensue. Perhaps this could lead to a discussion of local extinction vs total extinction.

If plant biology and adaption is a significant topic in your course – you might consider showing slides of these adaptations for hitching a ride on other things ie. the burrs, darts, spears, parachutes, and tiny balls of thorns. You could also extend the discussion of seed dispersal strategies to others not included in the passage – such as seeds surviving digestion and spread in the scat of the organisms that ate the seeds.

Investigation of the microscopic – possibly even nanoscale strategies for seed dispersal- could be explored. This could lead to a discussion of the concept of biomimicry and the story of VELCRO@, a revolutionary fastening material for shoes and myriad other products. VELCRO@ was the inspiration of Mr. George de Mestral, a Swiss engineer who, while walking his dog in the Jura Mountains of Switzerland, wondered how cockle-burs stuck fast to his pants and his dogs fur. His curiosity led to the development of the hook and loop material that is VELCRO@.

Finally, depending on your location and the time of year this exercise is taught, I might ask students to bring a seed in to class and to discuss its "appliance of activity" or otherwise provide a variety of examples of seeds and have students observe, make comparisons and generate hypotheses about the mode of dispersal employed by each.

If more time is available, and you would care to expand the passage explored and the depth of analysis it provides, Chapter 3 in Grapes of Wrath is a modest two pages in length but rich in further ecological insight.

From Cannery Row – Chapter 6

Doc was collecting marine mammals in the Great Tide Pool on the tip of the Peninsula. It is a fabulous place: when the tide is in, a wave-churned basin, creamy with foam, whipped by the combers that roll in from the whistling buoy on the reef. But when the tide goes out the little water world becomes quiet and lovely. The sea is very clear and the bottom becomes fantastic with hurrying, fighting, feeding, breeding animals. Crabs rush from frond to frond of the waving algae. Starfish squat over mussels and limpets, attach their million little suckers and then slowly lift with incredible power until the prey is broken from the rock. And then the starfish stomach comes out and envelops its food. Orange and speckled and fluted nudibranchs slide gracefully over the rocks, their skirts waving like the dresses of Spanish dancers. And black eels poke their heads out of crevices and wait for prey. The snapping shrimps with their trigger claws pop loudly. The lovely, colored world is glassed over. Hermit crabs like frantic children scamper on the bottom sand. And now one, finding an empty shell he likes better than his own, creeps out, exposing his soft body to the enemy for a moment, and then pops into the new shell. A wave breaks over the barrier, and churns the glassy water for moment and mixes bubbles into the pool, and then it clears and is tranquil and lovely and murderous again. Here a crab tears a leg from his brother. The anemones expand like soft and brilliant flowers, inviting any tired and perplexed animal to lie for moment in their arms, and when some small crab and any tide-pool Johnnie accepts the green and purple invitation, the petals whip in, the stinging cells shoot tiny narcotic needles into the prey and it grows weak and perhaps sleepy while the searing caustic digestive acids melt its body down.

Then the creeping murderer, the octopus, steals out slowly, softly, moving like a gray mist, pretending now to be a bit of weed, now a rock, now a lump of decaying meat while its evil goat eyes watch coldly. It oozes and flows toward a feeding crab, and as it comes close its yellow eyes burn and its body turns rosy with the pulsing color of anticipation and rage. Then suddenly it runs lightly on the tips of its arms, as ferociously as a charging cat. It leaps savagely on the crab, there is a puff of black fluid, and the struggling mass is obscured in the sepia cloud while the octopus murders the crab. On the exposed rocks out of water, the barnacles bubble behind their closed doors and the limpets dry out. And down to the rocks come the black flies to eat anything they can find. The sharp smell of iodine from the algae, and the lime smell of calcareous bodies and the smell of powerful protean, smell of sperm and ova fill the air. On the exposed rocks the starfish emit semen and eggs from between their rays. The smells of life and richness, of death and digestion, of decay and birth, burden the air. And salt spray blows in from the barrier where the ocean waits for its rising tide strength to permit it back into the Great Tide Pool again. And on the reef the whistling buoy bellows like a sad and patient bull.

The description of the Great Tide Pool captures much of the activity of the organisms who live there. Certainly, this passage supports analysis of trophic relationships, food chains and food webs. This includes predator and prey relationships, intraspecific and interspecific competition and the myriad structures and strategies for feeding. The stalking octopi uses changing skin color and skin texture to camouflage itself and speed and a "smokescreen" of ink to confuse and eventually subdue its prey. Scavenging flies complete the feeding picture. The inter-tidal is a fascinating habitat to study because of the unique conditions and challenges it presents the living things that live there. This includes pounding surf creating wave shock for creatures and exposure to the air and sun and submergence in cold briny waters twice a day with tidal changes. This leads to zonation of life in the inter-tidal. Changing water depth at a coastline brought about by tidal variation correlates directly with the time an organism will be exposed to the air and sun. Organisms in the zone closest to maximum low-tide will require adaptations that will allow them to survive relatively brief periods of exposure to air. Zones higher up and approaching high-tide will need adaptations that will allow those species to survive increasing longer periods of exposure to air and sun. Creating a tidal clock that is "superimposed" onto a diagram of zonation of the intertidal zone would be a powerful way to make this point. Have students create it and describe its implications. Looking more closely into the adaptations of the organisms in the tidal zone to survive this unique set of daily changes in conditions would also be a logical extension of this exercise. This passage reminds students to use all their senses when making observations including smell. Finally, the cycle of life runs full circle here as reproduction in considered – this might begin a conversation about reproductive strategies comparing K-select and R-select species.

https://www.youtube.com/watch?v=aoCzZHcwKxI&t=18s
Science Friday – Where's the Octopus?

From Cannery Row – Chapter 13

The Carmel is a lovely little river. It isn't very long but in its course it has everything a river should have. It rises in the mountains, and tumbles down a while, runs through shallows, is dammed to make a lake, spills over the dam, crackles among round boulders, wanders lazily under sycamores, spills into pools where trout live, drops in against banks where crayfish live. In the winter it becomes a torrent, a mean little fierce river, and in the summer it is a place for children to wade in and for fishermen to wander in. Frogs blink from its banks and the deep ferns grow beside it. Deer and foxes come to drink from it, secretly in the morning and evening, and now and then a mountain lion crouched flat laps its water. The farms of the rich little valley back up to the river and take its water for the orchards and the vegetables. The quail call beside it and the wild doves come whistling in at dusk. Raccoons pace its edges looking for frogs. It is everything a river should be.

A few miles up the valley the river cuts in under a high cliff in which vines and ferns hang down. At the base of this cliff there is a pool, green and deep, and on the other side of the pool there is a little sandy place….

There is no golden afternoon next to the cliff. When the sun went over it at about two o'clock a whispering shade came to the beach. The sycamores rustled in the afternoon breeze. Little water snakes slipped down to the rocks and then gently entered the water and swam along through the pool, their heads held up like little periscopes and a tiny wake spreading behind them. A big trout jumped in the pool. The gnats and mosquitoes which avoid the sun came out and buzzed over the water. All of the sun bugs, the flies, the dragonflies, the wasps, the hornets, went home. And as the shadow came to the beach, as the first quail began to call, Mack and the boys awakened.

This passage reveals the primacy of water. Water as a magnet for life. Water as the carver of canyons. Water as currency creating localized conditions that support a unique riparian community. The course of modest rivers in this region of California are discernable at a distance because they create a ribbon of green in an otherwise golden sea of grassland. This is the riparian ecosystem, supporting unique species and otherwise contributing to overall biodiversity in the region. This passage also hints at natural rhythms. What rhythms can you see in this excerpt? Are there seasonal rhythms? Are their daily or circadian rhythms implied? Is there a time of day better for fishing the Carmel River? If you like to observe certain wildlife from deer and foxes to "sun bugs", when would you visit the little sandy place next to the cliff? What insights about animal behavior can you infer from this passage? What do you think a microclimate is? Is the little sandy beach next to the cliff a microclimate, and if so, what evidence do you have to defend your response? What does it mean to be everything a river should be? What are the ecosystem services a river provides?

From Cannery Row – Chapter 17

Doc had to keep up his collecting. He tried to get to the good tide along the coast. The sea rocks and the beaches were his stockpile. He knew where everything was when he wanted it. All his articles of trade were filed away on the coast, sea cradles here, octopi here, tube worms in another place, sea pansies in another. He knew where to get them but he could not go for them exactly when he wanted. For Nature locked up the items and only released them occasionally. Doc had to know not only the tides but when a particular low-tide was good in a particular place. When such a low-tide occurred, he packed his collecting tools in his car, he packed his jars, his bottles, his plates and preservatives and he went to the beach or reef or rock ledge where the animals he needed were stored.

Now he had an order for small octopi and the nearest place to get them was the boulder-strewn inter-tidal zone at La Jolla between Los Angeles and San Diego. It meant a five-hundred-mile drive each way and his arrival had to coincide with the retreating waters.

The little octopi live among the boulders imbedded in sand. Being timid and young, they prefer a bottom on which there are many caves and little crevices and lumps of mud where they may hide from predators and protect themselves from the waves. But on the same flat

there are millions of sea cradles. While filling a definite order for octopi, Doc could replenish his stock for the cradles.

For the real estate agent the mantra is “location, location, location.” For the ecologist the refrain is “habitat, habitat, habitat.”

This passage introduces the inter-tidal zone and the critical idea of habitat. Simply put, where you find an organism is predictable, in that, there are places where an organism is ideally suited, and physical and chemical conditions of a given area determine the distribution of many organisms. The inter-tidal zone, ie. the zone of life found between high and low-tides is variable with lunar and solar positions – again – illustrating the necessity of knowing and working with natural rhythms in nature. The inter-tidal also demonstrates variation in the substratum or rock type (think beach sands vs rocky shoreline). As it relates to substratum, some animals prefer sandy shores, solitary clams for example dig into inter-tidal sandy beaches, others species prefer inter-tidal coastlines with craggy rocks covered with seaweed to cling to, such as colonial bundles of mussels.

The final paragraph about the behavior and preferred habitat of young octopi is also great for discussion. This could lead to consideration of their full life cycle. Do older octopi still inhabit this area or do they move to new areas as they mature? Octopi are mobile organisms and they may seek out new habitat as they mature, but many of the organisms in the inter-tidal are sessile – attached for nearly their entire lifetime. Why? What lifestyle makes staying in one place “work” for these creatures? What is being described when the habitat of sea cradles and octopi are one in the same?

Chapter 8 - The Log of the Sea of Cortez p. 49

The exposed rocks had looked rich with life under the lowering tide, but they were more than that: they were ferocious with life. There was an exuberant fierceness in the littoral here, a vital competition for existence. Everything seemed speeded-up, starfish and urchins were more strongly attached than in other places, and many of the univalves were so tightly fixed that the shells broke before the animals would let go their hold. Perhaps the force of the great surf which beats on this shore has much to do with the tenacity of the animals here. It is noteworthy that the animals, rather than deserting such beaten shores for the safe cove and protected pools, simply increase their toughness and fight back at the sea with a kind of joyful survival. This ferocious survival quotient excites us and makes us feel good, and from the crawling, fighting, resisting qualities of animals, it almost seems that they are excited too.

We collected down the littoral as the water went down. We didn’t seem to have enough time. We took samples of everything that came to hand. The uppermost rocks swarmed with Sally Lightfoots, those beautiful and fast and sensitive crabs. With them were white periwinkle snails. Below that, barnacles and Purpura snails: more crabs and many limpets. Below that many serpulids- attached worms in calcareous tubes with beautiful purple floriated heads. Below that, the multi-rayed starfish, Heliaster kubiniji, of Xanthus. With

Heliaster were a few urchins, but not many, and they were so placed in crevices as to be hard to dislodge. Several resisted the steel bar to the extent of breaking – the mouth remaining tight to the rock while the shell fell away. Lower still there were to be seen swaying in the water under the reefs the dark gorgonians, or sea-fans. In the lowest surf-levels there was a brilliant gathering of the moss animals known as bryozoans, flatworms, flat crabs, the large sea-cucumber, some anemones, many sponges of two types, and calcareous. There were great colonies of tunicates, clusters of tiny individuals joined by a common tunic and looking so like the sponges that even a trained worker must await the specialist's determination to know whether his find is a sponge or a tunicate. This is annoying for the sponge being one step above the protozoa, at the bottom of the evolutionary ladder, and the tunicate near the top, bordering the vertebrates, your trained worker is likely to feel that a dirty trick has been played upon him by an entirely too democratic Providence.

We took many snails, including cones and murexes; a small tectibranch (of a group to which the sea-hares belong); hydroids, many annelid worms; a red pentagonal starfish. There were the usual hordes of hermit crabs, but oddly enough we saw no chitons (sea-cradles), although the region seemed ideally suited to them.

We collected in haste. As the tide went down we kept a little ahead of it, wading in rubber boots, and as it came up again it drove us back. The time seemed very short. The incredible beauty of the tide pools, the brilliant colors, the swarming species ate up the time. And when at last the afternoon surf began to beat on the littoral and covered it over again, we seemed barely to have started. But the buckets and jars and tubes were full, and when we stopped we discovered we were very tired.

The opening paragraph of this passage demonstrates the concept of resilience, the ability of organisms to adjust to and bounce back from the elemental forces that impact them, in this case, in dealing with the wave shock conditions of the inter-tidal zone and the exposure to sun and air brought on by the tides. This passage also vividly demonstrates the competition for space as being a limiting factor in the inter-tidal, as every rock or other substratum is covered or otherwise exploited by multiple lifeforms. The clear zonation, also described in other passages, is also illustrated here and this passage could also be paired up with a "tidal clock" to make inferences about the adaptations and ability of different species to survive increased exposure to air and sun. Discussions of population density and diversity could be engendered by this passage. Further, this passage could be a springboard to look into the broader topic of invertebrate lifeforms and the taxonomic classification scheme.

Chapter 10 March 18 The Log of the Sea of Cortez

There is a curious idea among unscientific men that in scientific writing there is a common plateau of perfectionism. Nothing could be more untrue. The reports of biologists are the measure, not of the science, but of the men themselves. There are as few scientific giants as any other kind. In some reports it is impossible, because of inept expression, to relate the descriptions to the living animals. In some papers collecting places are so mixed or ignored

that the animals mentioned cannot be found at all. The same conditioning forces itself into specification as it does into any other kind of observation, and the same faults of carelessness will be found in scientific reports as in the witness chair of a criminal court. It has seemed sometimes that the little men in scientific work assumed the awe-fullness of a priesthood to hide their deficiencies, as the witchdoctor does with his stilts and high masks, as the priesthoods of all cults have, with secret or unfamiliar languages and symbols. It is usually found that only the little stuffy men object to what is called "popularization," by which they mean writing with a clarity understandable to one not familiar with the tricks and codes of the cult. We have not known a single great scientist who could not discourse freely and interestingly with a child. Can it be that the haters of clarity have nothing to say, have observed nothing, have no clear picture of even their own fields? A dull man seems to be a dull man no matter what the field, and of course it is in the right of a dull scientist to protect himself with feathers and robes, emblems and degrees, as do other dull men who are potentates and grand imperial rulers of lodges of other dull men.

I find this passage useful to help frame a discussion of the discipline of science for students, many of whom likely view it with a degree of trepidation and perhaps disdain. Steinbeck's humanizes the discipline, stating that there are people doing meaningful work who can readily share its significance with the rest of us, while other scientists may be less gifted in their ability to communicate or are less inclined to do so, preferring to hold on to their mantle of "expertise" – keeping their "discoveries" obscured and obtuse. During a time of fake news and attacks on science, I find it useful to orient students as to why science matters. I describe it ultimately as "a basis for good decision-making." To understand how the natural world operates is to prod humanity to find alternative-approaches to living well and sustainably on this planet. Science matters.

Chapter 25 April 22 Page 198 The Log of the Sea of Cortez

Meanwhile, the water seemed almost solid with tiny fish, one and one-half to two inches long. Sparky went to the galley and put the biggest frying pan on the fire and poured olive oil into it. When the pan was very hot he began catching the tiny fish with the dip nets, a hundred or so in each net. We passed the nets through the galley window and Sparky dumped them into the frying pan. In a short time these tiny fish were crisp and brown. We drained, salted, and ate them without any cleaning at all and they were delicious. Probably no fresher fish were ever eaten, except perhaps by the Japanese who are said to eat them alive, and by college boys, who are photographed doing it. Each fish was a curled, brown, crisp little bite, delicate and good. We ate hundreds of them. Afterwards we went back to the usual night practice of netting the pelagic animals which came to the light. We took shrimps and larval shrimps, numbers of small swimming crabs, and more of the transparent fish. All night the hissing rush and splash of hunters and hunted went on. We had never been in water so heavily populated. The light, piercing the surface, showed the water almost solid with fish-swarming, hungry, frantic fish, incredible in their voraciousness. The schools swarm, marshalled and patrolled. They turned as a unit and dived as a unit. In their millions they followed a pattern minute as to direction and depth and speed. There must be some fallacy in

our thinking of these fish as individuals. Their functions in the school are in some as yet unknown way as controlled as though the school were one unit. We cannot conceive of this intricacy until we are able to think of the school as an animal itself, reacting with all its cells to stimuli which perhaps might not influence one fish at all. And this larger animal, the school, seems to have a nature and drive and ends of its own. It is more than and different than the sum of its units. If we can think in this way, it will not seem so unbelievable, that very fish heads in the same direction, that the water interval between fish and fish is identical with all the units, and that it seems to be directed by a school intelligence. If it is a unit animal itself, why should it not so react? Perhaps this is the wildest of speculation, but we suspect that when the school is studied as an animal rather than as a sum of unit fish, it will be found that certain units are assigned special functions to perform; that weaker or slower units may even take their places as placating food for the predators for the sake of the security of the school as an animal. In the little Bay of San Carlos, where there were many schools of a number of species, there was even a feeling (and "feeling" is used advisedly) of a larger unit which was the inter-relation of species with their interdependence for food, even though that food be each other. A smoothly working larger animal surviving within itself- larval shrimp to little fish to larger fish to giant fish- one operating mechanism. And perhaps this unit of survival may key into the larger animal which is the life of all the sea, and this into the larger world. There would seem to be only one commandment for living things: Survive! And the forms and species and units and groups are armed for survival, fanged for survival, timid for it, fierce for it, clever for it, poisonous for it, intelligent for it. This commandment decrees the death and destruction of myriads of individuals for the survival of the whole. Life has one final end, to be alive; and all the tricks and mechanisms, all the successes and all the failures, are aimed at that end.

This passage refers to a phenomenon that scientists today describe as "collective intelligence" an important field of behavioral study when looking at networks. Again, Steinbeck hints at a "superorganism," a concept which has not been validated scientifically, never the less he has identified compelling behavior and brought interest and energy to learning more about it even if his speculation is perhaps a bit ahead of itself. The following two videos found on YouTube can be used to both illustrate and elaborate upon school or collective intelligence.

https://www.youtube.com/watch?v=Y-5ffl5_7AI
bioGraphic California Academy of Sciences

https://www.youtube.com/watch?v=15B8qN9dre4
this is a segment from the BBC program Earth

Chapter 27 April 8 The Log of the Sea of Cortez

In about an hour we came to the Japanese fishing fleet. There were six ships doing the actual dredging while a larger mother ship of at least 10,000 tons stood farther offshore at anchor. The dredge boats themselves were large, 150 to 175 feet, probably about 620 tons. There

were twelve boats in the combined fleet including the other ship, and they were doing a very systematic job, not only of taking every shrimp from the bottom, but every other living thing as well. They cruised slowly along in enchelon with overlapping dredges, literally scraping the bottom clean. Any animal which escaped must have been very fast indeed, for not even the sharks got away. Why the Mexican government should have permitted the complete destruction of a valuable food supply is one of those mysteries which have their ramifications possibly back in pockets it is not well to look into.

We wished to go aboard one of the dredge boats. Tony put the Western Flyer ahead of one of them, and we dropped the skiff over the side and got into it. It was not a friendly crew that looked over the side of the iron dredge boat. We clung to the side, almost swamping the skiff, and passed our letter from the Ministry of Marine aboard. Then we hung on and waited. We could see the Mexican official on the bridge reading our letter. And then suddenly the atmosphere changed to one of extreme friendliness. We were helped aboard and our skiff was tied alongside.

The cutting deck was forward, and the great dredge loads were dumped on this deck. Along one side there was a long cutting table where the shrimps were beheaded and dropped into a chute, whether to be immediately iced or canned, we do not know. But probably they were canned on the mother ship. The dredge was out when we came aboard, but soon the cable drums began to turn, bringing in the heavy purse-dredge. The big scraper closed like a sack as it came up, and finally it deposited many tons of animals on the deck – tons of shrimp, but also tons of fish of many varieties: sierras, pompano of several species, of the sharks, smooth-hounds and hammer-head; eagle rays and butterfly rays; small tuna; catfish; puerco – tons of them. And there were bottom samples with anemones and grass-like gorgonians. The sea bottom must have been scraped completely clean. The moment the net dropped open and spilled this mass of living things on the deck, the crew of Japanese went to work. Fish were thrown overboard immediately, and only the shrimps kept. The sea was littered with dead fish, and the gulls swarmed about eating them. Nearly all the fish were in a dying condition, and only a few recovered. The waste of this food supply was appalling, and it was strange that the Japanese, who are usually so saving, should have done it. The shrimps were shoveled into baskets and delivered to the cutting table. Meanwhile the dredge had gone back to work.

…We liked the people on this boat very much. They were good men, but they were caught in a large destructive machine, good men, doing a bad thing. With their many and large boats, with their industry and efficiency, but most of all with their intense energy, these Japanese will obviously soon clean out the shrimps of the region. And it is not true that a species thus attacked comes back. The disturbed balance often gives a new species ascendancy and destroys forever the old relationship.

In addition to the shrimps, these boats kill and waste many hundred tons of fish every day, a great deal of which is sorely needed for food. Perhaps the Ministry of Marine had not realized at that time that one of the good and strong resources of Mexico was being depleted. If it has

not already been done, catch limits should be imposed, and it should not be permitted that the region be so intensely combed. Among other things, the careful study of this area should be undertaken so that its potential could be understood and the catch maintained in balance with the supply. Then there might be shrimps available indefinitely. If this is not done, a very short time will see the end of the shrimp industry in Mexico.

We in the United States have done so much to destroy our own resources, our timber, our land, our fishes, that we should be taken as a horrible example and our methods avoided by any government and people enlightened enough to envision a continuing economy. With our resources we have been prodigal, and our country will not soon lose the scars of our grasping stupidity. But here, with the shrimp industry, we see a conflict of nations, of ideologies, and of organisms. The units of the organisms are good people. Perhaps we might find a parallel in a moving-picture company such as Metro-Goldwyn-Mayer. The units are superb – great craftsmen, fine actors, the best actors in the profession – and yet due to some overlying expediency, some impure or decaying quality, the products of these good units is sometimes vicious, sometimes stupid, sometimes inept, and never as good as the men who make it. The Mexican official and the Japanese captain were both good men, but by their association in a project directed honestly or dishonestly by forces behind and above them, they were committing a true crime against nature and against the immediate welfare of Mexico and the eventual welfare of the whole human species.

The year this passage is referring to is 1940. Nearly 80 years later, has our approach to harvesting the bounty of our oceans changed and, if so, how? Are we even more efficient at exploiting the resources of our oceans than we were in 1940 or has our approach matured, are we more thoughtful, less wasteful, less intrusive and destructive? Looking at the fishing operation, which is essentially a dredging operation, is also informative as the desired catch, the shrimp, are harvested as the complex ecosystem of the sea-floor is destroyed in the dredging process. This operation results, not only in the "collateral damage" of by-catch where many commercial fish species go to waste, but it is the equivalent of clear-cutting a forest as the entire sea-floor ecosystem is disrupted by this process. This gets at the nature of a disturbance that many species may find difficult to bounce back from. This is also an example of aquatic habitat destruction and the unravelling of an entire food web of specie interaction. Certainly, this passage can be used as a basis for research on the state of our oceans today and to investigate modern fishing practices. Laws of the sea and the protocol, agreements, and treaties that govern them can also be investigated under the broader concept of "a shared commons." This passage confronts the industrial paradigm for efficiency with the often destructive trade-offs it requires of the environment. It hints at important questions about the role of governments in protecting a nation's resources for its people. It goes beyond moralizing about what other nations should do and confronts our own legacy of exploitation and environmental destruction. It suggests that more scientific research is required before we can begin to know what represents a sustainable approach to fishing. Ultimately, it brings home the idea that we live in a world of limits and confronts us with the stark reality that we will need to find new ways to live sustainably on Earth.

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That night we intended to run across the Gulf and start for home. It was good to be running at night again, easier to sleep with the engine beating. Tiny at the wheel inveighed against the waste of fish by the Japanese. To him it was a waste complete, a loss of something. We discussed the widening and narrowing picture. To Tiny the fishermen, having as his function not only the catching of fish but the presumption that they would be eaten by humans, the Japanese were wasteful. And in that picture he was very correct. But all the fish actually were eaten; if any small parts were missed by the birds they were taken by the detritus-eaters, the worms and cucumbers. And what they missed was reduced by the bacteria. What was the fisherman's loss was a gain to another group. We tried to say that in the macrocosm nothing is wasted, the equation always balances. The elements which the fish elaborated into an individuated physical organism, a microcosm, go back again into the undifferentiated macrocosm, which is the great reservoir. There is not, nor can there be, any actual waste- the dead fish to man, the broken pieces to gulls, the bones to some and the scales to others- but to the whole, there is no waste. The great organism, Life, takes it all and uses it all. The large picture is always clear and the smaller can be clear- the picture of eater and eaten. And the large equilibrium of the life of a given animal is postulated on the presence of abundant larvae of just such forms as itself for food. Nothing is wasted; "no star is lost."

What does the author mean when he uses the term "the great reservoir" and when he suggests the notion that "no star is lost?"

This is a great illustration of one of the most important principles of ecosystem sustainability. Simply put, waste does not go to waste. The remains of and wastes produced by an organism are consumed, broken down, and recycled as the raw materials of the next generation of life. Life recycles itself to keep the ecosystem sustainable. This could be used in conjunction with a discussion of biogeochemical cycles and an investigation of the processes which keep the elements fundamental to life such as nitrogen, carbon, hydrogen, oxygen, phosphorus, and sulfur available in an ecosystem.

What does the author mean when he states "the great organism, Life, takes it all and uses it all?"

Steinbeck hypothesized the concept of a "superorganism" – the idea that there is such a complex set of relationships between living things that it maybe they function together as one unit. While this concept has not been scientifically established, it might be a place to start a discussion of the Gaia Hypothesis - from the Google online dictionary:

the theory, put forward by James Lovelock, that living matter on the earth collectively defines and regulates the material conditions necessary for the continuance of life. The planet, or rather the biosphere, is thus likened to a vast self-regulating organism.

An Introduction to Flash Fiction

In the teaching of writing and literary analysis – flash fiction has become a useful tool.
Here is how Grant Faulkner, Editor of 100 word story describes Flash Fiction:

I think of flash fiction as being one part story, one part poem. Plot matters less than mood and telling details–yet it does matter. I try to search for a subtle pivot, a surprising juxtaposition. I try to write to the drift of a story rather than in its grain. The joy of flash fiction as a writer and a reader is found not only in the words of the story, but in what is left out–the absences can be almost spectral, haunting what's been told, only guessed at. Sometimes, a short short is like playing the Ouji board. You have to settle for a small part of the story and let your imagination communicate with the other side to know the rest of it.

From the review review: views on publishing
Quote after the article Flash Fiction: What's It All About by Becky Tuch
http://www.thereviewreview.net/publishing-tips/flash-fiction-whats-it-all-about

Here is an example of a 100 word flash fiction.

If Kissed by a Dragon Fish

If kissed by a dragonfish, do not bite. If kissed by a dragonfish, make sure you are sitting. Do not worry during the kiss, before the kiss, or after. Do not worry about a scale or two between your teeth. The dragonfish's skin is armoured but its heart beats loud and soft. You will not forget the kiss. You will not forget the coolness of the dragonfish's breath inside your lungs. You will look down through the floor of glass and see nothing, swimming. You will part, like an ocean, and on your sea bed you will pearl.

By Tania Hershman

from 100 word story - the art of the fragment
National Flash Fiction Day Story - Third Place winner, 2014