### Structure

**Lede**

Begin on Tatoosh Island. Bob Paine, facing rough seas while out fishing for salmon, makes a “heroic landing” and becomes entranced. It’s a place of great natural beauty, teeming with life, mostly undisturbed by people, and rich with rocky shores where experiments could be set up and left untouched for decades. It was a place where a man could chuck starfish off rocks in peace.

**Nut**

Explain Paine’s seminal experiment (done a few years earlier on the mainland, where he removed starfish from the shore and found that mussels advanced, dramatically changing the local ecosystems. This leads to the creation of the keystone species concept – the realisation that ecosystems aren’t in equilibrium, and that removing certain critical species can have a massive knock-on effect. Also mention: a) some of the other insights he’s known for, and b) that he’s a pioneer of the experimental side to ecology.

But Paine is a keystone himself. Description of him today. He still goes to and works in Tatoosh. He’s mentored a rich and thriving legacy of students and postdocs, many of whom have become key figures in ecology themselves. Mention some of them and their achievements. And they’ve largely stuck within the same fields. On their websites, all his students are either wearing a lifejacket or reclining against the side of a boat.

Science is a legacy endeavour, where each generation stands on the shoulders of those before, and inherits ideas, practices, skills, attitudes, philosophies. How does someone like Paine inspire an entire field?

**Body I**

This is Paine’s bit – his background, his big discoveries, his approach to science, how he mentored his students etc. We get to know the man a bit more.

Cover his basic chronology: his start as a young birder in Massachusetts, learning the value of data collectios and natural history; moving to Washington and seeing the intertidal for the first time; that first experiment of prying starfish off rocks with a crowbar and flinging them out to sea; finding Tatoosh and setting up a ramshackle research base there... all with the running theme of careful natural history observation. Lots of colour about what Tatoosh is like – it’s a central feature to this story so it’ll be worth going into what it’s like, and it’ll ground the story more than just anecdotes of people would.

Context: it was a time of great change in ecology, where experimental approaches championed by Paine and Joe Connell were coming to the fore. Paine’s way of doing science was radically changing the field, and his ideas would do the same. I’ll flesh out his major discoveries, and how they changed ecology.

Also: His relationship with his students. Paine strongly encouraged individuality, and championed the idea of the pensive, solitary scientist – out in the field, breathing in natural history, working largely independently. He didn’t dole out projects, but would get students to devise their own. He’s not a saint—he can be intimidating, challenging and competitive, but he also supported his students and took great joy in their company, citing them as the thing he loved most about his job. He maintainted a Spartan atmosphere on Tatoosh, with everyone doing their bit, but a fun atmosphere too, with almost familial camaraderie and a lot of practical joking. He also gave his students sole authorship rights to their papers, unless he was heavily involved – something that they say taught them **XXXX**. That’s almost unthinkable in today’s academic climate

Two things worth discussing, if only briefly: what would happen if Paine was reborn today? Would his approach work? And contrast Paine to Joe Connell, who was his contemporary, who also pioneered experiments in ecology, but who (with some notable exceptions) hasn’t fostered the same wide legacy).

There was also something about the time: ecology ripe for change and a new approach being championed. And the place: this lonely island where students could explore, manipulate and bond. And the people: a guy who liked mentoring, and hungry young ecologists. The perfect environment for one person to exert top-down cascades

**Body II**

This is the next generation. We talk about how Paine’ students and how they expanded upon his scientific ideas, and we focus on one particular line in the dynasty – Bruce Menge and Jane Lubchenco (hereafter known as Lubmengo for typing ease).

The students expanded Paine’s ideas in several important directions. Some have gone into completely different areas like climate change, or using whale genetics to track down illegal meat. Others expanded on Paine’s original concepts. They showed that keystones were context-dependent so that a keystone in one area is just another species in another, and environmental factors set their influence – bottom-up as well as top-down. They provided more examples of trophic cascades in different ecosystems, of domino effects spreading after one species is removed. They expanded Bob’s studies in scale, running the same experiments around the world to see how environmental factors changed the ways in which species interacted. (Several of them helped to redefine a keystone in a famous meeting in Hawaii. The term had gone out of control & was being used to describe virtually anything that’s good. Policy wonks needed a functional definition.)

Lubmengo was at the heart of many of these developments. They carried on Paine’s experimental traditions, divvying up the entire food web between them. They set up a joint lab, both working half-time tenure-track positions (him: impetuous and always available; her: methodical and appointment-only), and went on to raise their own rich web of academic children, who they mentored in the Paine style. (They even had a real child of their own, who accompanied the Paine clan on field trips and is now an ecologist with his own lab).

But Lubmengo also took things in directions that aren’t very Paine at all. Ecology slowly entered the Big Science era, with large-scale data collection projects, and initiatives where similar experiments are carried out throughout the world to understand how ecosystem dynamics change with space and environmental conditions. One of these – PISCO – is run by several Paine students (Lubmengo included), studying ecological change in the oceans on a global scale. One guy can chuck starfish off a rocky coastline. To study the world, you need a team.

Paine hates Big Science. Ever the solo scientist, or at most, fond of small teams, large collaborations is an anathema to him. Doing the same thing at different sites turns students into boring machines, and robs them of the playful, self-propelled philosophy that he tried to instil. Pushing towards big collaborations was, as Lubchenco says, “rebelling against your parents.”

Then, there’s the policy angle. Lubchenco is now administrator of NOAA (as has been profiled by Nature already) and has done more than any of Paine’s students to connect basic ecological research to issues like fisheries management and Deepwater Horizon. Lubchenco speaks of growing up in an “anti-being relevant” academic culture: more rebellion. Paine has moved towards conservation and policy, though, including everything from salmon fisheries to Exxon Valdez. Everyone else seems to think it reflects a hidden passion for it; he says: “I was bullied into it.”

**Body III** + **kicker**

Where we are now. We meet some of the 2nd generation, including Menge-Lubchenco’s students, and we see what Paine’s students are getting up to now.

Lubmengo’s students benefited from their joint mentorship, and their interests in not just big-scale marine science, but policy applications too. I can give several examples of this, but I’ll probably focus on Steve Gaines – the prodigal child. A true descendant of Paine and Lubmengo, he’s an experimental ecologist, with creative ideas and strong mentoring skills (won an award for that), but also fond of collaborations and policy work. He’s the prime example of what Lubchenco calls “use-inspired science”. That is, basic research that will have an immediate impact on policy decisions.

His work on the dispersal of marine larvae over long distances is still about interactions, like those that Paine studied on single shores, but expanded to entire oceans... and it’s helping to show fishermen that no-take marine reserves (where fishing is completely banned) actually benefits them by providing larvae to re-stock fished areas. There are other examples, that I’ll go into.

[Here’s the bit that needs a bit more fleshing out, but I want to spend a little bit of time – maybe not a huge amount – either looking at this tier, or going one tier down. A few possible candidates at this tier. One option is to look at Gaines’ students. He highlighted a woman called Kate Smith, who went from working on larval dispersals to infectious diseases, and how the transport of humans and animals around the world affects the risk of epidemics. It seems like a fitting coda to the Paine legacy – not just predators on a beach, but every trophic level on a global scale.]

All of this current work, including the policy angles of Gaines, Lubchenco and others – the ability to deal with the big environmental and conservation problems of our day – critically hinges on the processes that Paine discovered. You need to know about interactions, top-down effects, keystones, to be able to manage an ecosystem.

Paine, meanwhile, is still active. He’s off to Patagonia. He’s back to Tatoosh (and checking up on old experimental sites). The island work is now run by two Painites – Tim Wootton and Cathy Pfister. New graduate students are wetting their scientific (and literal) feet there. Paine goes along, mind sharp as ever, but feet moving more tentatively – he has lost binocular vision, and his daughter helps him about.