# Braking for the Planet-Learning the Limits

By Lorne Fitch, *P. Biol*

It would have been the wildest hyperbole to have called my father a patient teacher, especially in coaching someone to drive a car. He came from a lineage where sons were expected to observe and then flawlessly perform whatever action was demonstrated. Thankfully my mother enrolled me in a driver training course or I would still be a pedestrian.

There, under the tutelage of a very patient instructor, I learned many important driving tips, not the least of which was the idea that stop signs meant **stop**. They were not yield signs to motor through when the traffic seemed light. The other was the concept of leaving suitable distances between yourself and other moving vehicles to make safe stops possible. I wasn't to realize until much later how relevant these fundamental driving tips were to a grounding in ecology.

Technology has gotten in the way of good driving skills. Cruise control, a standard feature on most modern vehicles, is a servomechanism that takes over the throttle of the car to maintain a steady speed set by the driver. It is a curious bit of technology, at least as far as most of us use it. Watch, on any highway, as other drivers with cruise control engaged are reluctant to disengage it when approaching another vehicle, coming into a curve or an area of traffic congestion. Cruise control can be disengaged with a flick of a finger or a touch of the brake, yet the tendency is to keep speed up, despite looming danger. Brake lights flash at the last possible moment. Failure to disengage in a timely way can lead to unsafe and dangerous responses, collisions, and death.

I offer the unsafe use of cruise control as a metaphor for our over-consumptive lifestyle. We happily give control over to a machine, are reluctant to slow down to match changing conditions, and believe things will all work out. This is resource use on autopilot, mind unengaged, attention unquestioning, using things up at a speed that isn't safe and hoping we can steer around the issues coming up much too quickly in front of our grill. Rather than cruise control, it really is cruising with little or no control.

My driving instructor instilled in me the concept of defensive driving, being observant, engaged, and understanding limits. Perhaps we should apply these principles to how we manage the earth's resources and our future.

So, braking for the planet before the planet breaks is essential. Fundamental to this ethic is the reality of finite limits to space, resources, and energy. This is couched in a variety of terms. A *tipping point* happens when a small shift in pressure or condition brings about a large, often abrupt change in a system. Often synonymous with *threshold*, once a tipping point is passed an ecosystem is unlikely to be able to return to its previous state because its resilience is compromised. There are also *regulatory limits,* points in some variable up to which a risk of system change is permitted (as in legislation or policy) or accepted (as in social or economic values).

What are some safe speeds for resource use and what are the limits, tipping points, and thresholds and, where should we stop?

Before a tipping point is reached populations, habitat, and ecosystems have the ability to bounce back, to rebound from pressures and stressors. Once that point is reached and exceeded, like a rubber band stretched too much, elasticity is lost, a snap occurs and the ability to rebound back to a robust form is lost.

The change may be dramatic, like a light switched off. Fish disappear with a chemical pollutant above a certain concentration, a swift change in the pH, an exceedance of thermal limits, or a stream dries up due to drought or diversions. For many species of wildlife the cause is too much human traffic and the associated disturbance.

Arctic grayling population declines in the Wapiti River watershed were studied by Adam Norris for his 2012 MSc thesis. Many things can individually kill fish, but usually it is a combination which work together synergistically. The Wapiti watershed has an extensive land use footprint of logging, petroleum development, agriculture, motorized recreational uses, high road density and losses of riparian buffers. With less water came higher water temperatures; more nutrients, like phosphorus in the runoff, depleted dissolved oxygen, especially under times of low flow. High water temperatures coupled with low dissolved oxygen levels led to losses of arctic grayling in many streams. But, the critical threshold, the line between extant populations and missing ones was a threefold increase in phosphorus concentrations over pre-development levels, a function of changes from land use.

Recent University of Alberta research on the relationship between roads and grizzly bears indicates that areas with road densities greater than 0.6 km/km² have fewer bears. Areas with quality habitat and fewer roads have the most bears. Clayton Lamb, the principal researcher summarized the work with: "Not only do bears die near roads, bears also avoid these areas making many habitats with roads through them less effective."

Other wildlife, like elk, avoid roads and areas within 500 metres of roads (and the human/vehicle traffic) which constrains effective use of habitat in landscapes with high road densities. Research on elk populations and their reaction to roads shows a threshold of 0.55 km/km², beyond which elk avoid such busy landscapes.

The change might be less dramatic, more gradual, like a dimmer switch, where a population declines on a gradient, until the light of resilience goes out. Fish and wildlife populations require a critical mass, a minimum viable number, to maintain themselves. This is expressed as the smallest number of individuals in a population capable of persisting over time without winking out from natural and/or human causes. Once the numbers drop below that point, the chances of successful reproduction to fill the void are overwhelmed by additive mortality, such as changes in suitable habitat conditions and/or competition with non-native species. The end happens, not with a bang, but with a whimper.

The density of roads and trails that bisect the landscape is a case in point. Roads and native trout don't mix well. All linear features – roads, trails, pipelines, skid trails and the like – intercept runoff, capture and redirect it downhill faster, increase erosion along the way, and then dump excess water and sediment into a watercourse, to the eventual dismay of trout. Fisheries biologists generally agree that the best road density to protect trout is zero roads/km².

Travis Ripley, in his MSc thesis research, found increasing road density in the Kakwa sub-watersheds from 0 km/km² to 0.6 km/km² was associated with a decline in the probability of occurrence of bull trout from 60 percent to 20 percent, a drop of 67 percent. David Mayhood, an independent fisheries biologist, points out, based on the literature, there is no road density threshold below which there is no effect.

In stark terms this means with any road development in a watershed, the best available science shows that bull trout and cutthroat trout populations can be expected to decline. All native trout populations are at risk in the Eastern Slopes and many species like bull trout, cutthroat trout, and Athabasca rainbows are "threatened".

Highways, roads, railways, and to a great extent pipelines, powerlines, logging roads and off highway vehicle (OHV) trails are the fracture zones, the schisms separating and impacting intact landscapes and the creatures dependent on them. Where linear density has been calculated for the Eastern Slopes, it currently exceeds 2.0 km/km² and is as high as 5.0 km/km². Clearly, these are levels that exceed limits by several orders of magnitude.

Road density can be an index for many other factors like the total human land use footprint and the overall effects of that footprint on runoff patterns in a watershed. The land use footprint affects how water flows off the landscape, when it does, and the extent of runoff. Removal of forest canopy, by logging, can increase flows in the spring but result in lower late season flows. This can exacerbate both flooding and droughts. Neither benefit native fish.

A collaborative research effort, undertaken in the lower Athabasca region (that includes the Athabasca tar sands area) and published in the journal *Environmental Review* (2015), documented the effect of land use on flow patterns and fish. The researchers found an increased flow variability of 20 percent in hydrologic patterns over time from land clearing, logging, road building, and mining (including the diversion of streams to accommodate tar sand removal). These activities increased sediment loads, contributed to other changes in water chemistry, increased the flashiness of watersheds, and changed base flows from pre-development conditions. The effect of this on three native, migratory fish species was a 53-100 perecent decline in populations following a 15 percent change in the landscape due to the footprint of human land uses.

Prairie grasslands and many of the bird species that nest there are not immune from human footprints. Jason Unruh, in his 2015 Master's thesis *"Effects of Oil Development on Grassland Songbirds and their Avian Predators in southeastern Saskatchewan"* noted effects from noise, well density, conversion of native grassland, traffic, and human activity. Limiting relationships on sensitive species became apparent at a disturbance threshold of only 3 percent of the landscape. As Unruh pointed out: "These are not large scale disturbance factors yet they still have detectable effects on grassland songbird abundance."

At a global scale, given current rates of greenhouse gas emissions, the temperature is projected to rise 2.7°C. This doesn't sound like much, like an insignificant threshold. But, with that temperature increase comes the real risk of tipping points for the melting of Arctic sea ice, the Greenland ice sheet, and the Antarctic ice sheet. Melting ice causes a rise in sea levels, maybe by a metre. This may seem insignificant… except for people living on the coasts or islands in the worlds' oceans. Currently the storm surge risk for New York City is once every 100 years. With a one metre rise in sea level the storm surge risk for the city changes to once every three to four years, hardly insignificant.

A threshold is a line drawn in sand, that an ecologist or a climatologist says is a stop sign. To ignore it to risk serious consequences and repercussions. Extreme weather events, plummeting populations of grassland bird species, native fish hanging on by a fin and crashing caribou numbers are all grains of sand in the beaches of evidence indicating we have exceeded critical ecological and climate thresholds in our pursuit of economic advantage.

We live in a time when too many wants compete now with too few remnants of wild places and wild things. Because we did not want to think about or engage in limits we have landscapes replete with consequences and complications. It is easier to dream than to unseat a culture drunk on the illusion of plenty, impatient with restrictions, determined to wring more from a landscape than can be done sustainably.

Cruise control for our cars was an invention that made us lazy and complacent in our driving habits. Ignoring or avoiding ecological limits has had a similar effect on our decision making function for appropriate amounts of land/resource use. New cars with advanced safety systems, to help avoid or mitigate collisions, are already on the market. Examples include automatic emergency braking, forward collision warning, and blind-spot warning. Imagine if we applied the concept of this technology to the landscape to help us avoid approaching or crossing essential ecological thresholds.

But, it isn't technology we need, but rather it's the discipline to set and maintain limits on our activity. How hard can it be to apply the brakes? Perhaps, if we learn to use the brakes, the next step will be to shift into reverse and begin the task of restoring the places where we've exceeded the limits.

*Lorne Fitch is a Professional Biologist, a retired Fish and Wildlife Biologist and an Adjunct Professor with the University of Calgary.*