Millions of Pacific salmon return from the ocean to spawn in thousands of streams throughout British Columbia. Sockeye salmon migrate astonishing distances through the mighty Fraser basin to the northern Interior to spawn in tributaries of the Stuart-Takla lakes over 1,000 kilometres from the ocean — watersheds that are dominated by hybrid white spruce, subalpine fir and lodgepole pine. In the Great Bear Rainforest of the central and north coast, all six species of salmon (chinook, chum, coho, pink, sock-eye and steelhead) are supported by hundreds of small watersheds containing old-growth forests of western redcedar, western hemlock, amabilis fir and Sitka spruce that are managed under ecosystem-based management.

BC salmon are a cultural and ecological icon of our province. Not only are they crucial to the cultures and economies of many communities, they also support important species for biodiversity — grizzly bears, bald eagles, and orca whales to name a few. I have spent much of my scientific career studying how salmon and their marine-derived nutrients affect biodiversity in the Great Bear Rainforest.

Forest Practice and Policy Implications
One of my key research goals as a graduate student at the University of Victoria and as a postdoctoral researcher at Simon Fraser University was to document how salmon nutrients affect riparian plant communities. We found out that bears, wolves and other species drag lots of half-eaten salmon into the forest; that stream water flow links dissolved nutrients from salmon to soils and the root networks of trees; and that salmon nutrients can be detected in the tissues of riparian plants over 100 metres from the spawning channels. But what evidence is there that salmon affect plant growth or diversity?

Some of my recent analyses from more than 50 streams in the Great Bear Rainforest have shown that salmon increase riparian plant productivity. At streams that support a high density of spawning salmon we observed plant communities that are dominated by nutrient-loving species (such as salmonberry and stink currant), higher nutrient quality (nitrogen content of leaves) and faster tree growth. Surprisingly, nutrient subsidies from salmon also caused a decrease in plant diversity because a few species can out-compete the others for salmon nutrients. The result is often dense thickets of salmonberry and stink current laden with berries that are consumed by many mammals and birds, or large and fast-growing Sitka spruce trees that play important functional roles for salmon as fallen large woody debris in streams. Salmon thus change the structure and functioning of riparian communities.

Another surprising finding of our work was how the type of watershed can affect how much salmon nutrients change riparian plant communities. For example, a key factor is the stream gradient and the slope of the riparian zone, which mediates how salmon nutrients are retained within...
Clockwise from top left: Wolf predation on chum salmon beside a small stream. Wolves eat just the salmon head and leave the remains to fertilize the forest.
Large Sitka spruce in the riparian zone of a small stream on the BC central coast.
Large woody debris modifies stream structure and helps retain salmon carcasses.
Salmonberry plants growing on the bank of a small salmon stream on the central coast of BC.
the watershed. Other factors include stream size and the predominance of red alder, a nitrogen fixer. This means that salmon subsidies do not always have a strong effect, particularly when the background productivity of a site is already high, when the water is too deep for bears to access the fish, or when watershed morphology or flow regimes limit nutrient retention.

The role of salmon in influencing riparian function is thus often greatest along low gradient, small to medium-sized streams. Conversely, we know that forests also have the strongest influence on the function of streams along smaller streams and headwaters compared to large downstream areas. Streamside vegetation strongly affects streams including the amount of light that reaches the channel, water temperature, the rate and kind of organic matter inputs, bank stability and channel structure. All of these factors affect salmon.

Under the Forest and Range Practices Act (FRPA), riparian areas around large (>1.5m) fish bearing streams are afforded some protection from harvesting. These 40-100 metre wide buffers include a riparian reserve zone, with no harvesting permitted, and a riparian management zone with restrictions on harvesting. In contrast, small headwater and non fish-bearing streams (S4-S6 streams) are afforded less protection. These streams receive smaller buffers and only management zones, which in practice are often completely harvested. Ironically, this can negatively affect salmon populations because harvesting headwaters can influence stream flow, sedimentation and channel structure in the downstream reaches for 10-20 years or more post harvest. These effects have been studied at Carnation Creek, Stuart-Takla and others as a part of BC’s Fish-Forestry interaction research (http://www.for.gov.bc.ca/hre/ffi).

Since harvesting headwaters can negatively affect salmon in downstream reaches, this leads to several management questions: 1) Is it possible to increase protection of headwater streams and still maintain profits from forest harvesting? 2) Does it make sense to reallocate harvesting opportunities from headwaters back to productive downstream reaches?

In the Great Bear Rainforest, I think it makes the most sense to build community based forest economies. Local First Nations are reasserting their rights to their traditional territories and are engaged in government-to-government negotiations in resource management. Some feel that the current industrial forest model and tenure system may not be working. Profits for companies are poor, local jobs are few and costs will increase with more pressure for better environmental standards under ecosystem-based management. These local communities have extensive knowledge of salmon, their streams and ecological links such as the salmon-forest association, and thus are possibly in the best position to devise management strategies that balance the full range of forest values. An option to consider could be smaller-scale community-based forest economies with more local processing of wood products and a focus on high quality, fast growing trees subsidized by healthy populations of salmon.

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emphasize different options in their choice of silviculture systems. Despite the high elevation, long growing seasons allow them to capitalize on rotations approximately half the length of our own. Capulalpam’s community forest managers focus on small openings and rely on natural regeneration as the primary means of stand re-establishment. Artificial regeneration was generally only used to fill gaps where natural regeneration had failed to sufficiently re-stock the stand. Sustainable forest practices are a constant in both their short and long-term planning. The trip exceeded all expectations for the 11 Selkirk students, who shared their experience with fellow students, faculty and members of the public during a slide show presentation several weeks after the trip. “It was really eye-opening to see such a different approach to forestry,” enthused Nick Rothenburger in summing up his thoughts on the trip.

Stefanie Bulmer concurred with her classmate’s assessment, adding, “It will definitely influence future management decisions that I’ll make in my forestry career.” It required a remarkable cooperative effort between administrators, instructors, students and sponsors to make the trip happen but we now know that with the proper effort and a little luck, an educational experience like this can transform from dream to reality.

Carol Andrews, RPF, is an instructor in the forest technology program at Selkirk College in Castlegar. Carol has a master’s degree in interdisciplinary studies with a focus on global change. She worked as a forestry consultant for over 20 years before joining the college. Jesper Nielsen, RPF, worked as a forest manager in Nakusp for 20 years before joining the forestry faculty at Selkirk in September 2012. Jesper has a degree in international relations from UBC, but gravitated back to his logging town roots and completed his forestry degree from UBC in 1993.