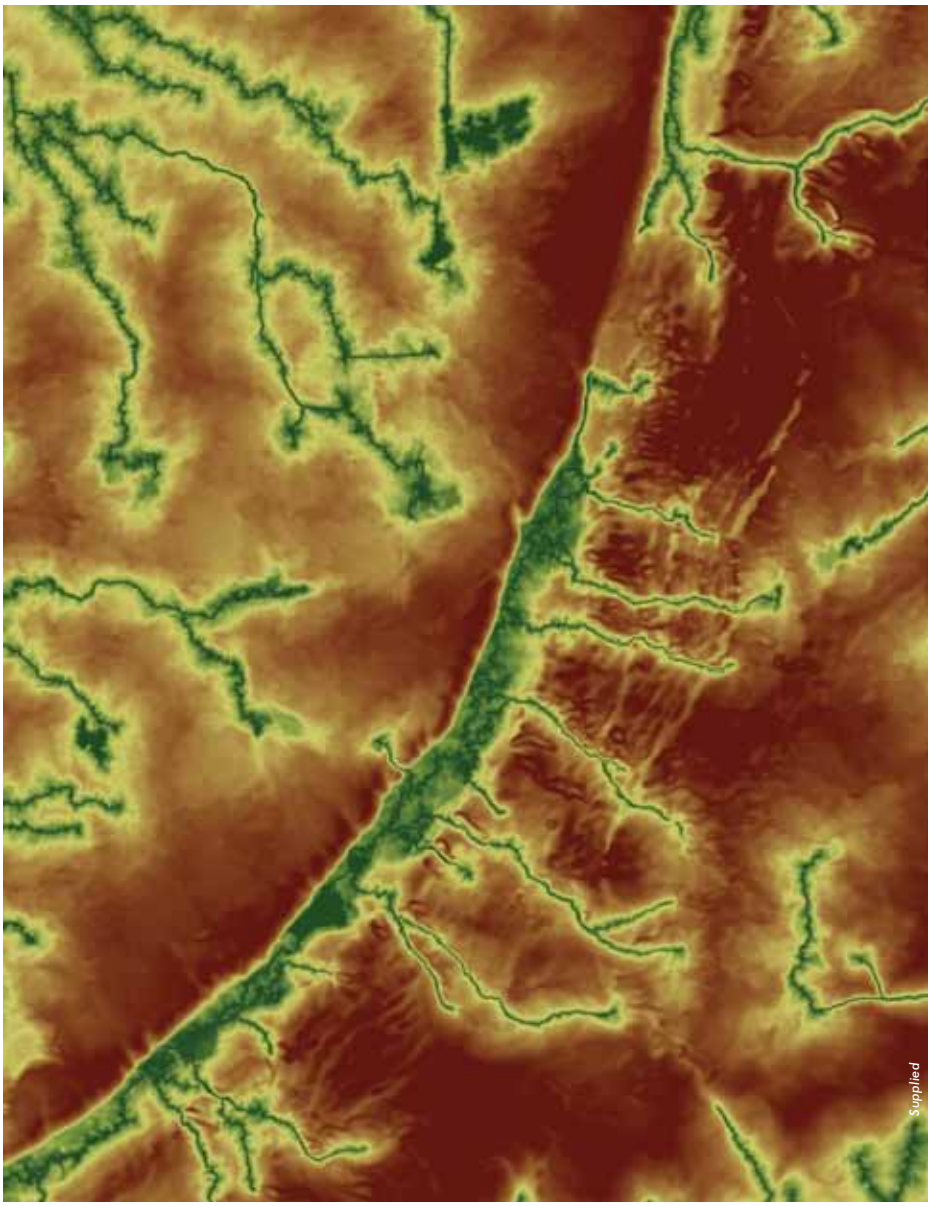
LiDAR-based vegetation type mapping in Alberta

By PAUL ARP, DOUG HILTZ AND BARRY WHITE

Mapping vegetation type at high resolution, using LiDAR-derived digital elevation models (DEMs) and DEM-derived wet area maps (WAMs), is of great interest to foresters, park managers, conservationists, naturalists and land-use planners across Canada. Such mapping will improve insight, accuracy, and operational and regulatory efficiencies at local to regional scales pertaining to:

- Delineating the natural habitat and eco-sites for floral species, from wetland to dry-land obligatory species, including rare species, from small pockets to large ranges;
- Selecting site-suited plant species for reclaiming disturbed locations, from wet to dry areas;
- Projecting and analyzing pathways and migration routes of flora and fauna, including invasive species;
- Planning trails in and access routes to parks, forests and rangelands while minimizing physical, chemical and biological disturbance impacts on natural habitats and migration routes;
- Locating best available sites for industrial and residential developments; and
- Refinement of existing site classification models and growth and yield models.

Currently, research efforts sponsored by Alberta Sustainable Resource Development and Alberta Parks, Tourism and Recreation focus on high-resolution vegetation type indexing within the Wilmore Wilderness Area and the western boreal plain as represented by the Ecosystem Management Emulating Natural Disturbance (EMEND) research study. The lead researcher on this new research effort is Doug Hiltz who is a graduate student at the University of New Brunswick.



Vegetation index for EMEND study area showing progression of expected vegetation habitat types from those in wet areas (darkest green) to those in dry habitats (darkest red)

The graphic on this page provides an example of a LiDAR-derived vegetation index map (in raster format) that is based on (i) the LiDAR-derived DEM; (ii) the DEM-derived wet-areas map with all its surface-water features and flow channels, each starting with a four ha flow-accumulation threshold; (iii) the WAM-derived cartographic delineation of the depth-to-water (DTW) between the mapped flow-channels and open-water features; and (iv) the conversion of DTW into the vegetation index (VI) with additional slope and aspect adjustments at each raster cell.

The index (VI) so derived can be used to represent the vegetation type gradient across the landscape from hydric (as in depressions) to xeric (as on ridge tops or steep south facing slopes). As shown, plot-based VI determinations have been shown to be in good agreement with the LiDAR-derived VI map.

The goal of this current research effort is to refine this VI mapping process and facilitate its adoption in other areas of Alberta where needed and desired.

Innnovation spurs stewardship solutions

By PAUL ARP, DAVID CAMPBELL AND BARRY WHITE

Alberta offers significant opportunities for outdoor recreation to Albertans and its many visitors. The province has articulated a vision that ensures present and future recreationalists have access to public lands for outdoor recreational opportunities that are both safe and environmentally sustainable.

However, Alberta's expanding economy, rapid population growth, evolving recreation trends and linear access on public lands are dramatically increasing the demand for recreation opportunities. These demands, in turn, are contributing to significant impacts on wildlife, vegetation, soil, and water and causing conflict between recreationalists and other public land users.

Alberta Sustainable Resource Development (ASRD) looks to the science community to develop innovative, effective and leading edge management techniques that empowers its partners and outdoor enthusiasts to both manage and create extensive outdoor recreational trail systems in a manner that is consistent with environmental stewardship.

The Forest Watershed Research Centre at the University of New Brunswick (UNB) has developed the Trail Routing, Analysis, Investigation, and Layout Tool (TRAIL Tool) which designs trail routes in a manner that minimizes construction and maintenance costs, reduces environmental footprint and enhances rider safety.

ASRD has partnered with the university to modify this software for trail development use in Alberta. This effort is led by David Campbell, a graduate student at the Forest Watershed Research Centre, who with funding from ASRD, is helping to create high-resolution solutions for recreational sustainability.

At the core of this model are the newly acquired LiDAR digital terrain maps (DTM) and wet areas mapping (WAM) coverage for Alberta. With LiDAR-DTM alone, trail planners and users have a new means to interpret local variations in slope, view sheds, terrain ruggedness, and other terrain indices. With the LiDAR-derived WAMs, trail planners and users realize much detail about encountering hydrological risks along existing and planned trail routes across many as yet un-mapped flow channels and wet areas.

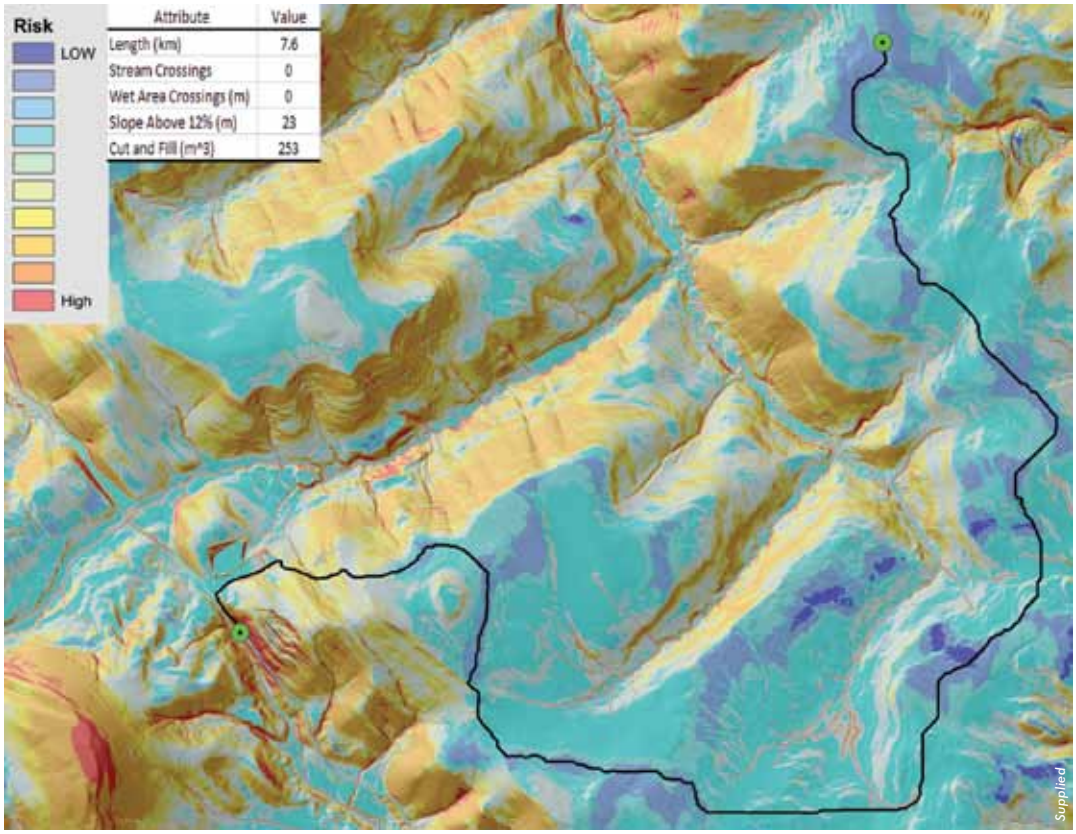
The Ghost River Forest Land Use Zone, which has seen much environmental impact over the years, serves as a land base for tool testing. Campbell's thesis research represents a partnership between the Forest Watershed Research Centre at UNB, the Ghost-Waiparous Stewardship Council and ASRD's Lands and Forestry Divisions.

The TRAIL tool creates hazard theme maps which reflect users' perception of risk and benefits through interactive risk assessments and trail-specific hazard identification. In detail, this tool asks the user what trail-specific activities are planned, and how activities such as landscape viewing, time-in-saddle, crossing difficult terrain can be optimized along the trails. Sensitivities like not traversing unstable slopes, crossing stream channels and wet areas, encroaching upon ecologically unique areas, and cutting across faunal migration routes are some of the items that can be addressed with the tool.

Additional features within the tool allow a group to conduct trail layouts and informed discussions as per preferences and tradeoffs between route alternatives, thereby improving forehand knowledge of potential risks along existing and planned trails.

The TRAIL tool is expected to reduce hydrological footprint of newly constructed trails through reductions in stream and wet area crossings and reduce soil disturbance impacts. The tool is also expected to greatly reduce planning and construction times. A planning process that might take weeks to months, involving substantial resources and many field validation checks can now be reduced to days with a one-time field reconnaissance trip for route verification and final adjustments. The ultimate goal is that alternative trails can be visualized, compared and evaluated within hours, all at a fraction of the cost.

It is anticipated the TRAIL planning software will be available for use by Albertans in the spring of 2012, and that any recreation trails to be built from that point forward will have a much lower environmental footprint, without compromising on safety and rider satisfaction.



LiDAR-generated trail hazard map for a portion of the Ghost River FLUZ, based on user preferences that results in reductions in trail construction costs and a systematic reduction of hydrological risks such as stream crossings, soil disturbance and trail passage through wet areas.

Science partnerships help protect water resource

By AXEL ANDERSON AND JOHN DIIWU

Specialists within Forest Management Branch of Sustainable Resource Development have one foot in the scientific world and one foot in the policy world. Forest hydrology specialists John Diiwu of Edmonton and Axel Anderson in Calgary have been forging strong partnerships with leading researchers from numerous universities and with Alberta industries. Investments made in research activities and partnership building are now paying significant dividends in terms of forest industry competitiveness, policy development and environmental stewardship.

Science can be a slow process – it can be years before work is completed and published. However, graduate students often produce key results long before the formal publication process is complete. Both Anderson and Diiwu hold Adjunct Professor positions at the Universities of Calgary and Alberta respectively.

Their close association with university research and colleagues helps them stay on the cutting edge of science. Adjunct professor status allows direct involvement of Alberta Sustainable Resource Development (ASRD) staff with graduate students' thesis research, proposal writing and the strategic direction of local forest hydrology science. This means current knowledge that is both timely and strategic can be provided to support many government of Alberta policies such as the Land-Use Framework, Water for Life Strategy, Forest Management Plans, Operating Ground Rules, Prescribed Burn Plans, Mountain Pine Beetle Action Plans, Access Management Plans and more.

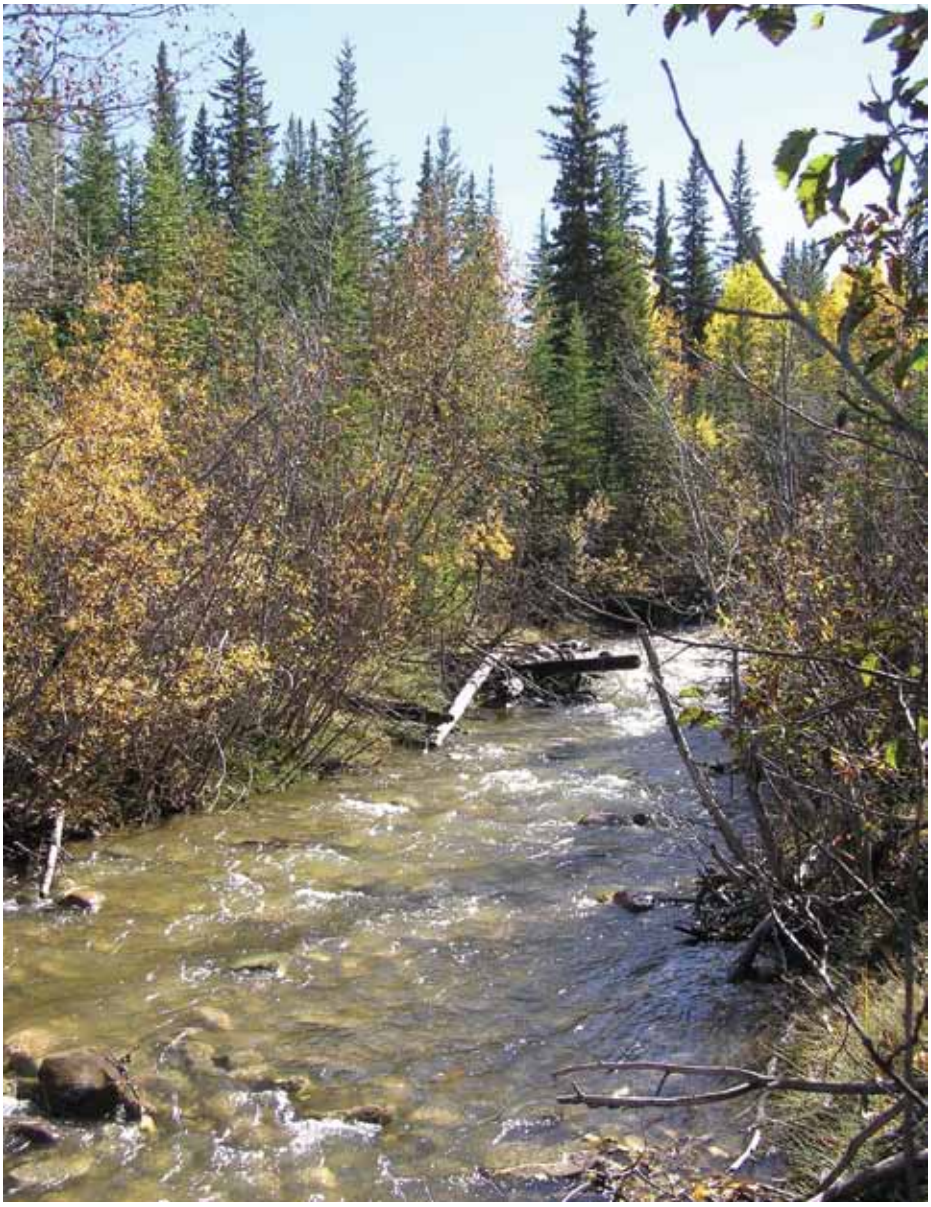
The need for effective partnerships is more important today than perhaps at any previous time because of the threat from mountain pine beetle (MPB). The beetle is a threat to many forest values including watershed processes and water resources. Trees use vast quantities of water and large expanses of beetle-killed trees affect the recharge and runoff from watersheds. Increased threat of large and intense wildfires in dead stands is another significant risk to watershed values.

As Alberta aggressively fights the spread of MPB from British Columbia, with the help of funding from ASRD, Anderson and Diiwu have partnered with academics and others to help understand how MPB and management strategies are likely to influence watershed values of the Rocky Mountains.

One such project, the Southern Rockies Watershed Project, was initiated in 2004 by Professor Uldis Silins of the University of Alberta following the 2003 Lost Creek wildfire south of Crowsnest Pass. The project was initially designed to understand the effects of large intense wildfires and timber salvage on water quality and ecology, but soon became an excellent opportunity for ASRD and partners to address questions related to MPB and forest hydrology in a cost effective manner.

Plans are underway to further expand this study to understand effects of forest management on water usage by downstream municipalities. Expanding the project was made possible by significant funding from the Alberta Water Research Institute, which was keen to study the downstream effect and implications for water treatment. These latter aspects are being studied by Professors Stone and Emelko of Waterloo University in conjunction with ASRD specialists.

ASRD has also partnered with Professor Sarah Boon who recently began her career at the University of Lethbridge as an assistant professor. She brings an impressive history of collaboration with the British Columbia Forest Service addressing how snow accumulates and melts under pine stands killed by MPB. The snow from the Rocky Mountains and foothill forests is the



Research provides insight into mountain watershed health

source of critical water supply for southern Alberta and much of the Prairie Provinces. Boon's students, partially funded by ASRD, provide a much needed addition to the Southern Rockies Watershed Project. They are currently investigating the snow processes and how to use innovative tools such as LiDAR to apply information to other sites with limited data.

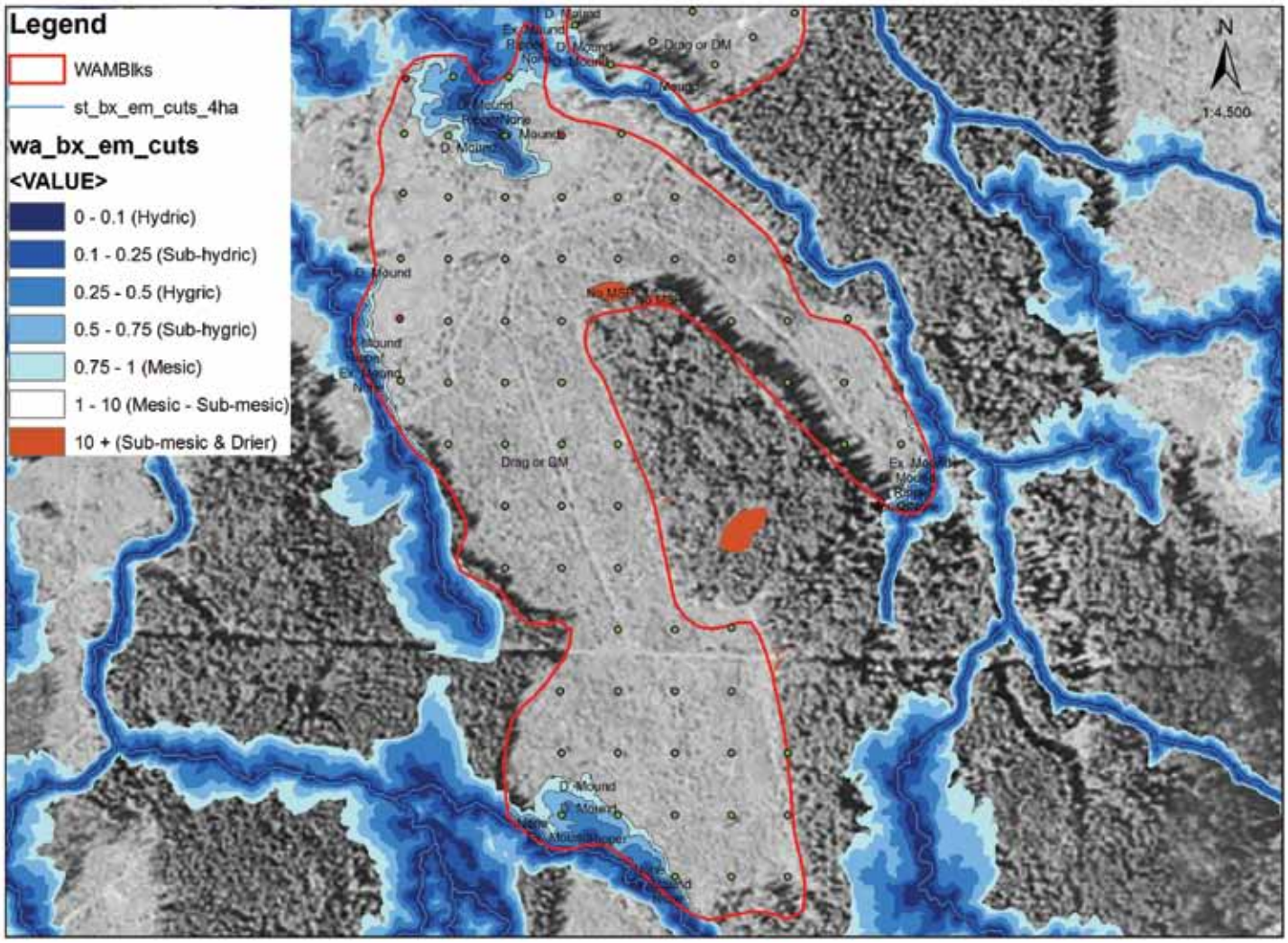
ASRD has also recently formed a new partnership with Professor John Pomeroy, forest hydrologist and Canada Research Chair (CRC) in Water Resource and Climate Change at the University of Saskatchewan. The goal of this partnership is to capitalize on the data from the Marmot Creek Hydrology Study which is Canada's only long–term forest hydrology study in the Canadian Rocky Mountains. This study was initiated in 1962 and ran until 1987, and provides extensive data records which are exceptionally valuable for researchers and policy makers today. The outcomes will be knowledge about how elevation, aspect and MPB may affect the critical snow accumulation and melt.

Professor Caterina Valeo of the University of Calgary has also partnered with ASRD to investigate the use of innovative hydrological modeling tools for larger-scale problems. She is investigating the reliability of models for determining the effect of MPB on the Elbow River watershed, a critical source of water supply for the City of Calgary.

ASRD specialists have also partnered with colleagues in British Columbia to exchange and leverage knowledge and ideas. They continue to use innovative hydrological modeling techniques developed at the University of British Columbia, and investigate innovative isotope techniques for forest watershed assessment from Oregon State University. They are also instrumental in the implementation of wet areas mapping developed at the University of New Brunswick.

The above examples demonstrate how ASRD has taken a leading role in addressing the knowledge gaps surrounding management of risk to watershed values.

It is important to note that Axel Anderson has been recently seconded to the Foothills Research Institute to develop and lead the newly created Water Program. This presents an excellent opportunity to continue building the strong partnerships that ASRD has developed with leading academics to address wider provincial issues such as cumulative effects. The goal of the new Water Program is to enhance the coordination of forest hydrology research in the province to support sustainable forest management and protect our water resources in the most effective and efficient manner.



Wet areas map developed through a partnership between SRD and the University of New Brunswick, in part, to reduce hydrological footprint