



Linking Strategic Science to Collaborative Management Outcomes for Three Priority Indicators Across the Crown of the Continent Ecosystem: Managing Invasive Species, Landscape-scale Change and Climate Change Adaptation

Project Coordinator: Erin Sexton, Crown Managers Partnership (CMP), University of Montana, Institute on Ecosystems; (406) 250-4779; erin.sexton@umontana.edu **AIS Co-Coordinators:** Caryn Miske, Crown Managers Partnership (CMP), Flathead Basin Commission; (406) 240-3453; cmiske@mt.gov; Cindy Sawchuk, Alberta Environment and Sustainable Resource Development (403) 678-1879; cindy.sawchuk@gov.ab.ca.

Principal Investigators: Greg McDermid, Department of Geography, University of Calgary; (403) 220-4780; mcdermid@ucalgary.ca; Erik Hanson, Flathead AIS Work Group; (406) 437-1440; esonofhan@yahoo.com; Kate Wilson, Alberta Environment and Sustainable Resource Development; (780) 644-6989; kathryn.wilson@gov.ab.ca, Alice Whitelaw, Working Dogs for Conservation

Project Partners: Crown Managers Partnership¹, Roundtable for the Crown of the Continent, Crown of the Continent Conservation Initiative, The Wilderness Society, Working Dogs for Conservation, Scott Nielsen, Garth Mowat, Gord Stenhouse

Project Summary: The Crown Managers Partnership (CMP) is developing collaborative management out-comes for three targeted indicators as part of our overall implementation of the Managing for Ecological Integrity Project². We are strategically focusing on Aquatic Invasive Species Landscape-scale Change, and Climate Change Adaptation, working effectively across jurisdictions; sharing data and utilizing a common science template. Our overall goal is to achieve amplified management out-comes that address these shared conservation threats. Specifically, in the coming year we will advance our management strategies with respect to each of the stressors by; (i) Assimilating on-going work at multiple scales and implement strategic pilot projects to address Aquatic Invasive Species (AIS), and develop a cohesive Transboundary Management Plan across the the Crown of the Continent Ecosystem (CCE), (ii) Develop a Human Modification Index for the CCE providing a quantifiable methodology for measuring landscape-scale integrity at the scale of the CCE, (iii) Complete a multi-species functional connectivity analysis for a suite of focal species and

¹ See <http://crownmanagers.org/steering-committee/> for a complete list of the CMP Partner Agencies

² The CMP's 'Managing for Ecological Integrity' program is a strategic priority of the CMP, and has identified Landscape Dynamics, Invasives and Climate Change Adaptation as priority Indicators of ecological integrity at the scale of the CCE. <http://crownmanagers.org/strategic-plan/>

link with on-going Trend Analysis for the CCE, and (iv) Prioritize and implement shared climate adaptation strategies in a coordinated effort with non-government organizations and community stakeholders. These strategies collectively advance the CMP's priorities for managing to a desired condition across the CCE, while providing for significant strategic alignment with the Great Northern LCC's conservation priorities and needs for a transboundary focal region within the Rocky Mountain Ecotypic Area.

Need: The CMP is a voluntary collaboration amongst jurisdictions and management agencies in the CCE, working to implement spatially-explicit transboundary outcomes for seven indicators of ecological integrity. *Given that no single agency has the mandate or resources to focus on the entire region, the CMP seeks to demonstrate a common, collective institutional capacity, across borders, to effectively manage the cumulative impacts of human activities and achieve commonly desired and defined transboundary environmental out-comes.* As with the Great Northern LCC, terrestrial and aquatic ecosystem functioning across the CCE is compromised by land-use conversions related to increasing levels of human activity, the spread of invasives, including aquatic invasive species (AIS), and the interaction between these and other stressors with climate change.

This project offers alignment with the goals of the Great Northern LCC in the following ways; 1) Amplification of management response and conservation out-comes with respect to large scale land-use changes, aquatic invasive species and climate change adaptation, three of the GNLCC's priority stressors, 2) Improving coordination across jurisdictions and increasing collaborative capacity, and 3) Providing a template and framework for AIS management that may be scaled up across jurisdictions and boundaries.

The science and information products from this project are relevant beyond the CMP and GNLCC, and collaborative partners and end-users include: The NPS Inventory and Monitoring Network, NPScapes, the Alberta Biodiversity Monitoring Institute (ABMI), the Foothills Research Institute, the USGS Northern Rocky Mountain Science Center, the State of Montana, Province of Alberta, Province of British Columbia, the Roundtable for the Crown of the Continent, the Practitioner's Network for Large Landscape Conservation, America's Great Outdoors and the Northern Rockies Adaptation Partnership.

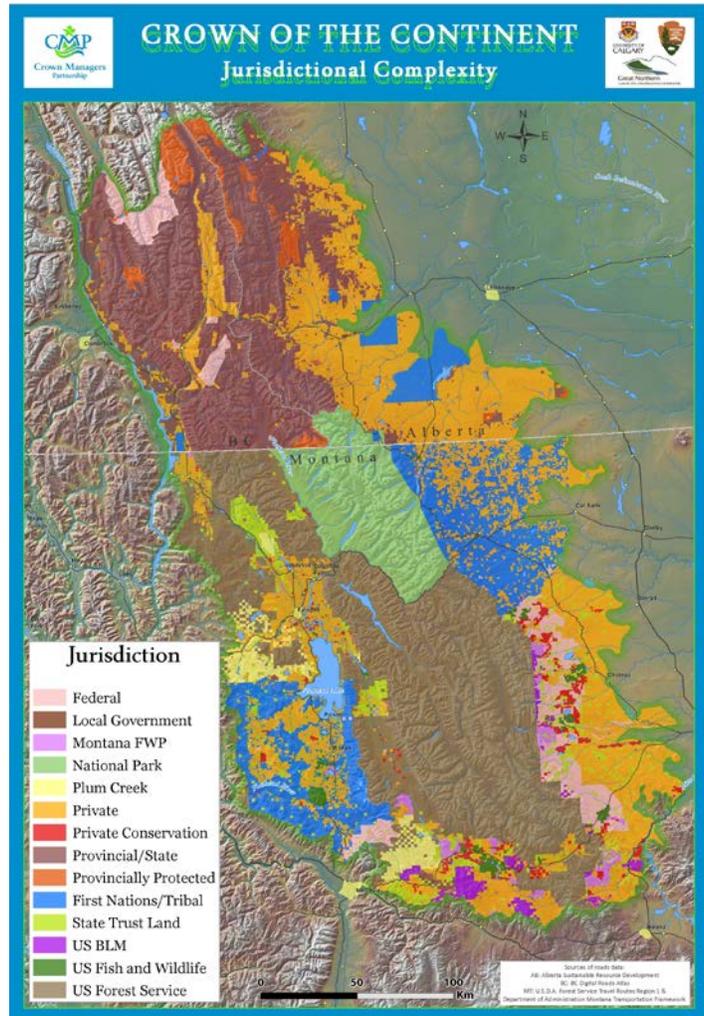


Figure 1: The Crown of the Continent Ecosystem.

Objectives: We will address the following objectives in FY 2014-2015

Objective I – Develop a Human Modification Index (HMI) for the CCE which will serve as a surrogate for Landscape Integrity and quantify the level of human use on the landscape.

Building on our existing seamless geo-spatial datasets and strategic workshops held in 2014³, we will develop a strategy for quantifying human use and modification across the CCE. Once developed, this methodology will be applied at two scales: (i) a coarser ‘meso-scale’ analysis will be conducted across the entire CCE using consistent transboundary layers, and (ii) a series of finer sub-regional/jurisdictional analysis will be performed using best available data. The purpose of the meso-scale analysis is to inform managers with respect to broad-scale trends and overall patterns of landscape integrity, since it uses consistent transboundary datasets that can be monitored through time as part of our on-going Trend Analysis work (see Objective III below). Meso-scale analysis is also key for prioritizing data gaps and identifying sub-regions where fine-scale analysis is needed. Beever et al. (2014) recently validated the utility of tracking landscape changes such as the CMP focal indicators of human use footprint, invasives and climate change impacts at the meso-scale, for documenting landscape-scale trend.

Objective II – Identifying focal species for functional connectivity analysis across the CCE

In 2012-2013, a spatially explicit grizzly bear model was created for the CCE using ecological variables compiled by the CMP and bear detection data provided by our partners in Alberta, British Columbia, and Montana. The work for this project is in its final stages, with the model and final paper under review by the PI’s. In addition to providing a basis for regional planning analysis to identify priority areas for conservation (led by Dr. Scott Nielsen) and trend monitoring (see Objective III below), the model represents the first step in on-going multi-species functional connectivity work currently underway. Our objectives on this topic have shifted away from pre-defined species that tend to focus on charismatic, high-profile megafauna (i.e. grizzly bear, wolverine, elk, etc) towards a more ecologically justifiable approach that involves the systematic identification of focal species whose needs are representative of as many other species in the ecosystem as possible. As such, we propose to extend the work currently underway on grizzly bear functional-connectivity analysis through mixed-methods approaches that (i) systematically identify a suite of focal species for the CCE, and (ii) focus on the development of methods that combine functional-connectivity models for multiple focal species across large landscapes.

Objective III – Continue on-going trend analysis at the scale of the CCE. The Landscape Analysis geospatial databases compiled across the CCE represent a single snapshot in time, and are designed to be updated (and, in some cases backdated) in order to document changes on the landscape through time. Work in the 2013 funding cycle focused on an update of land-cover and related attributes (roads, fires, human footprint) from the decade spanning 2000 to 2010 through change detection of Landsat and MODIS (Moderate Resolution Imaging Spectroradiometer) satellite imagery. In addition to summarizing the changes (land-cover conversions) and trends (vegetation recovery, degradation) occurring across the CCE, the work also provides the foundation for analyzing changes in higher-order models (e.g. grizzly bear occupancy, connectivity, human modification) derived from these base layers. Our objective is to complete this work in the current funding cycle and work to link these changes to on-going human modification (Objective I) and connectivity (Objective II) work.

³ <http://crownmanagers.org/landscape-patterns-workshop/>

Objective IV - Develop a cohesive Transboundary Management Plan for monitoring, prevention and rapid response of Aquatic Invasive Species across the Crown, with phased implementation via pilots.

In 2013, with GNLCC and CMP agency support, we initiated strategic tasks toward building a collaborative management protocol for AIS in the Crown. The pilot program was successfully expanded into Alberta and we convened discussions across the jurisdictions with respect to monitoring, prevention (watercraft inspection stations) and rapid response. In 2014-2015, we propose to initiate a pilot program for AIS detection dogs to be used at watercraft inspection stations in AB and MT. Demonstration of the utility of the dogs provides potential for the pilot to be scaled up regionally, with immediate, on-the-ground results. We will also implement focus group testing for existing AIS messaging to improve the educational component of AIS prevention, for application in the CCE and broader GNLCC regions. These pilots are part of the CMP, Province of Alberta, State of Montana, and Flathead Basin AIS strategies, and are candidates for scaling up to the GNLCC Pilot work on Aquatic Integrity and Invasives.

Objective V - Develop phased implementation of a suite of on-the-ground climate change adaptation strategies at nested scales across the CCE.

Building on strategic climate change workshops in 2010 and 2011⁴, the CMP will collectively prioritize a suite of management options for conservation delivery in response to, or in anticipation of climate change, or climate change impacted stressors. In 2014 and 2015, we are convening a series of workshops with the CMP membership, non-governmental organizations, community stakeholders and climate change adaptation experts from the greater region for three primary objectives; i) Build capacity and explore linkages for amplification across the CCE, ii) Identify shared adaptation strategies that anticipate climate change and build resilience in the CCE, iii) Identify areas to coordinate strategies at multiple scales, and iv) Select a suite of climate change adaptation strategies for CMP managers to implement, effectively linking multi-jurisdictional management objectives and community stakeholder objectives.

Objective VI - Communicate project outcomes within and beyond the GNLCC.

In 2014 and 2015, we are holding a series of workshops in Alberta, British Columbia and Montana, focused on Climate Change Adaptation (March, 2014 – Missoula), Aquatic Invasive Species (March, 2014 - Fernie), and Landscape-scale change (January and April, 2014, Fernie). These are strategic workshops, designed in two phases to develop consensus on best available knowledge and translation to conservation actions and management out-comes, and provide an opportunity for education and discussion with managers and public stakeholders. In addition to the core project objectives described above, we will continue promoting consistent methodologies across jurisdictional boundaries and advocating for data-sharing and dissemination across jurisdictions, designed to permit the un-restrained distribution of project data and outcomes. These include both technical efforts made by our data manager to distribute our products to CMP managers and collaborators through our project web site (<http://www.crownmanagers.org/ecological-health-project>), delivering data to LCMaP and to our secure data server (<http://136.159.65.20/index.php>), as well as advocacy activities designed to clarify and relax data-ownership issues associated with certain Canadian data sets.

Methods: An overview of the tasks required to complete the major objectives of this project are outlined below:

⁴ <http://crownmanagers.org/past-cmp-forums/>

Task 1: Develop a Human Modification Index (HMI) for the CCE. We are developing a methodology for both a CCE-wide meso-scale⁵ index of human modification/use, as well as finer scaled measures of HMI for targeted sub-regions within the CCE, where managers and scientists have prioritized conservation action. Our model of HMI will use human-mediated direct threats as identified by Salafsky et.al (2008), with appropriate adjustments, given the lack of complete datasets for each threat category across the entire CCE. This standard lexicon has been adopted by numerous studies (i.e. Theobald, 2013; Auld & Keith, 2009; Álvarez-Romero et al., 2011) and provides a common starting place to develop an HMI for the CCE. Our modified lexicon will be created using the best-available data that is available for the entire CCE.⁶

Task 2: Identification of representative focal species for functional-connectivity analysis. We will convene a panel of experts using a “reputation approach” described by Hess and King (2002) to identify participants in a study designed to identify a small number of representative focal species that best-represent the needs of other species in the CCE. Once identified, we will use the Delphi technique (see, for example, Oliver, 2002) and multiple rounds of surveys to build an anonymous, expert-based consensus on suitable focal species.

Task 3: Multi-species functional connectivity. Functional-connectivity modelling for grizzly bears is currently underway, and will be supplemented with additional models for other species identified in Task 2. We will use kernel-density connectivity analysis based on species-specific resistance surfaces and dispersal distance. The multi-species nature of this work is key, since it acknowledges the species-specific nature of connectivity, and makes allowances for the varying perceptions (resistance surfaces) and movement patterns (dispersal distances) of different organisms. Once determined, we will develop novel strategies for combining multi-species connectivity models into simple maps that convey the connectivity status of multiple species.

Task 4: Conduct broad-scale trend monitoring. Efforts in the 2013 funding cycle have focused on analyzing landscape transformations and trends from 2000 to 2010 using remote-sensing change detection. Efforts in the 2014 cycle will focus on translating these changes into higher-order models of human modification, grizzly bear occupancy, and functional connectivity in order to highlight the impact of these changes on human modification and habitat in the CCE.

Task 5a. Pilot the use of detection dogs for AIS prevention, containment and rapid response. A continuing challenge for overall AIS detection, of particular concern in the CCE, is the risk of mussels evading detection at watercraft inspection stations, despite rigorous inspection standards. In Minnesota and California AIS detection dogs are being successfully deployed to address this concern, and dogs have been successfully used for the detection of invasive zebra and quagga mussels. The CMP will ascertain if this methodology could be applied at watercraft inspection stations in the Crown. The proposed project would provide funding to train two dogs/handlers for the detection of invasive quagga and zebra mussels which would greatly improve our ability to detect both live and dead mussels at inspection stations. Data and results will be provided in a final report analyzing the capability of the dogs to detect mussels on watercraft. This work includes in-kind and funding matches from the Province of Alberta, State of Montana, Flathead Basin Commission and California Fish and Wildlife.

⁵ We are working at the *moderate* spatial scale (i.e. grain size in the 250m to 1km range) to represent landscape-level occupancy patterns across the entire study area.

⁶ The CMP Landscape Analysis database compiles existing ecological geospatial datasets across the transboundary CCE.

Task 5b. Conduct focus group testing of the effectiveness of existing AIS messaging. Across the GNLCC and the Crown regions, educational messaging for AIS is widely inconsistent. Additionally, none of the educational messages currently in use have been tested for their efficacy in either educating the public, or changing boating behavior.⁷ Focus group testing would enable the CMP to: (1) test existing messaging; and (2) revise/change educational messaging to better address public and to facilitate behavior change. Data and results will be provided in a final report, summarizing the testing results for (1) existing messaging; and (2) suggested changes to improve AIS educational campaign, which can then be cohesively implemented by the CMP and partners.

Task 6: Identify and implement strategic adaptation strategies in response to or in anticipation of climate change and other important cumulative stressors – We have designed a series of strategic workshops, initiated in 2010, with an increasingly refined objective of selecting two-three discrete adaptation strategies that the CMP managers can either lead or support implementation of, building on the best expertise and emerging practice within and beyond the CCE.⁸ In support of this work, we propose to conduct a statistical/quantitative analysis of watershed level snowpack (swe/depth) in areas of the Crown over the last decade that would yield a map of relative snowpack persistence by watershed, ranking those with the most consistent higher snowpack to those with the lowest consistent snowpack. To date, no analysis has been completed at the watershed level across the CCE to guide climate change adaptation efforts. This discrete piece of work will map watershed snowpack levels and quantify differences between watersheds, facilitating prioritization of adaptation options, dependent on water availability.

Task 7: Share data, communicate and disseminate geospatial data sets, methods, and science products – The CMP and GNLCC networks will be leveraged to share data, methodologies, tools and results developed from this project.

Deliverables and Schedule

- Quantifiable Human Modification Index (HMI) for the Crown of the Continent [Dec, 2014]
- Quantifiable HMI for targeted sub-regions/jurisdictions within the CCE [Feb, 2015]
- Report documenting the HMI methodology, results and discussion [Apr, 2015]
- Identification of focal species for the CCE, including a report documenting methodology, results and discussion [Dec, 2014]
- Functional connectivity model of grizzly bear across the CCE [Dec, 2014]
- Report on multi-species functional connectivity, including grizzly bears and other focal species [April, 2015]
- AIS Detection Dogs:
 - 2 dogs/handler teams trained/tested and deployed [Summer, 2014]
 - Final Report outlining the results from testing and deployment of AIS detection dogs [Fall, 2014]
 - 2 trained dog handler teams which can be deployed in subsequent years, assuming the pilot is successful [On-going]

⁷ Studies in Montana and elsewhere have shown that even while knowledge of the AIS issues increases, changes in boating behavior remain relatively stagnant.

⁸ Literature and methodologies for implementing climate change adaptation include Cross, et al. (2012), Proceedings of a Workshop on Climate Change Scenario Planning for the Crown of the Continent Ecosystem, 9-10 March 2010, Whitefish, Montana (Hartmann, 2013) <http://crownmanagers.org/past-cmp-forums/>

- Enhanced AIS educational opportunities at watercraft inspection stations due to public interaction with detection dogs [On-going]
- Positive media targeted to educate the public about on-the-ground efforts to combat AIS
- Focus group testing (4 focus sessions, 2 in Canada, 2 in MT) and final report [Fall, 2014]
- Standardized AIS monitoring protocols , AIS Strategic Plan and Annual Work Plan [2015-2016]
- Report on grizzly bear occupancy and connectivity analysis at the scale of the CCE, submitted to an appropriate peer-reviewed journal [Winter, 2014-2015]
- Two-three discrete climate change adaptation strategies to be implemented collaboratively across the CCE [Spring, 2015]
- Upload of meta-data and high-level products, data sharing within the GNLCC and other partners [on-going – complete Winter, 2015]
- CMP Workshops (in collaboration with other partners)[On-going]
- Final report summarizing findings [Winter, 2015]

Statement of Compliance: The CMP and Partners (Project Coordinator, Principal Investigator, Data Manager and GIS Specialist) have read the GNLCC Information Management, Delivery and Sharing Standards and agree to comply with those standards if the proposal is selected.

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