



eDNA and Genomics Research: Operational Applications in Northwest BC

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eDNA Research

Environmental DNA¹ (eDNA²) monitoring and assessment tools are being developed across Canada, and researchers at the University of Victoria (UVic) are leading the way in many respects, including efforts to make them useful in a broad range of contexts, collaborating with others in standardizing them, and demonstrating their value to a wide range of potential users.

Among these potential users are First Nations governments, many of which are looking to improve environmental impact monitoring and assessment practices to increase our collective understanding and protection of riparian resources. This is especially important in Northwest BC, given First Nations' reliance on salmon and other cold water fish species for food, social and ceremonial purposes and continued industrial and domestic development in their traditional territories.

Other potential users include Provincial and Federal governments responsible for stewardship and protection of Crown land and natural resources, as well as existing and potential industries utilizing natural resources.

¹ Deoxyribonucleic acid or DNA is a molecule that contains the instructions an organism needs to develop, live and reproduce. These instructions are found inside every cell and are passed down from parents to their children. (<https://www.livescience.com/37247-dna.html> June 20, 2018)

² Environmental DNA (eDNA) is DNA that an organism leaves behind as it moves through an environment [...] The eDNA stays behind in the environment, and slowly dissipates over time. (https://en.wikipedia.org/wiki/Environmental_DNA June 20, 2018)

The Bulkley Valley Research Centre (Centre) supports research that advances scientific understanding of sustainable resource management and pushes the boundaries of natural resources research and management applications. The Centre provides a stable platform to support the viability of longer-term research projects, which are essential for understanding the sustainability of our environmental resources. The Centre is pleased to promote collaborations that utilize new eDNA techniques to enhance the stewardship of our natural resources in Northwest BC.

eDNA Testing: A New Way to Detect Species' Distribution

Naturally occurring DNA can be collected from the environment and the presence of species' DNA can be tested from a scoop of water! The UVic Genomics Research Lab (Helbing lab³) is applying molecular expertise to develop robust tools for biologists to track **species distribution**⁴ using environmental DNA.

eDNA can help biologists determine: **what is happening to a specific species** (e.g. a species of interest, a species at risk, or an invasive species); **the population distribution of a species; the population dynamics of a species;** and, **disease presence** (e.g. if there is a pathogen in the water).

eDNA testing can be more effective than conventional methods, when combined with a wholistic understanding of the environment and monitoring programs.

Comparison between Conventional and eDNA Survey Methods

Attribute	Conventional Time-Constrained	eDNA Testing
Efficacy	Low-High	High
Multi-species	Sometimes	Yes
Adaptive Design / Testing	No	Yes
Retroactive Addition of Taxa	No	Yes
Observer Bias	High	Low
Permitting Required	Yes	No
Invasiveness / Lethal	High	Low
Pathogen Transfer Risk	High	Low
Timing of Sampling	Restrictive	Less Restrictive
Special Equipment / Training	Medium-High	Low
Safety Considerations	Medium-High	Low

³ <http://web.uvic.ca/~chelbing/>

⁴ See ProAqua eDNA Testing Brief

Available Validated eDNA Tests

Species	Common Name
<i>Oncorhynchus clarkii</i>	Cutthroat trout
<i>Oncorhynchus kisutch</i>	Coho salmon
<i>Oncorhynchus mykiss</i>	Rainbow trout
<i>Oncorhynchus nerka</i>	Sockeye salmon
<i>Oncorhynchus tshawytscha</i>	Chinook salmon
<i>Thymallus arcticus</i>	Arctic grayling
eFish	Generic fish
<i>Ambystoma mavortium</i> *	Western tiger salamander
<i>Ambystoma tigrinum</i> *	Eastern tiger salamander
<i>Anaxyrus (Bufo) boreas</i>	Western toad
<i>Ascaphus montanus</i>	Rocky mountain tailed frog
<i>Ascaphus truei</i>	Pacific (Coastal) tailed frog
<i>Lithobates (Rana) catesbeiana</i>	North American bullfrog
<i>Lithobates (Rana) pipiens</i>	Northern leopard frog
<i>Rana aurora</i>	Northern red-legged frog
<i>Rana cascadae</i>	Cascades frog
<i>Rana luteiventris</i>	Columbia spotted frog
<i>Rana pretiosa</i>	Oregon spotted frog
<i>Spea intermontana</i>	Great Basin spadefoot
eFrog	Generic frog
<i>Contia tenuis</i>	Sharp-tailed snake
<i>Sorex bendirii</i>	Pacific water shrew
eMammal	Generic mammal not human

Genomics Research: A New Way to Assess Wildlife Health

Aquatic wildlife act as sentinels for environmental and human health. They are apt indicators of pollutant and climate change effects. Genomics techniques⁵ can help biologists assess **animal health**⁶. Through the application of the latest genomics tools, the Helbing lab has developed accessible non-lethal health tests applicable to wildlife.

Collaborations

To enable the necessary collaboration among researchers and potential users of eDNA and genomics technology, the BVRC and the Helbing lab have joined forces to provide opportunities to participate in the further development and standardization of these tools, and to include

⁵ Genomics techniques include the evaluation of how the genetic blueprint of an animal is used to respond to its environment

⁶ See ProAqua Animal Health Brief

them in ongoing aquatic monitoring program development. The intention is that collaborations will lead to:

- identification and development of eDNA tools that will ensure that species important to First Nations are included in tool development
- the implementation of the new eDNA and genomics tools in the context of First Nations food, social and ceremonial purposes
- collaboration with a wide range of potential users in initial efforts to integrate new eDNA and genomics tools into existing and new monitoring programs

Operational Applications

Potential Application	Potential Cost-Saving
Detect presence/absence of an aquatic species in a territory or project area	Can sample more sites more frequently at less cost than traditional time-constrained searches
Confirm or refine actual habitat range of an endangered or invasive species	Multiple species can be tested for in the same water sample
Baseline studies for proposed projects	Simpler logistics for wildlife surveys
Permitting requirements – application of appropriate management standards	Increases certainty on what permitting requirements should be applied
Operational management decisions – tests can rapidly reveal biological impact	Provide more robust baseline information for environmental impact assessments
Industrial pollution testing (e.g. mine effluent, chemical spills) – tests can reveal sublethal deleterious effects	Less damage to sensitive environments
As an addition to current / ongoing aquatic monitoring programs to complement and refine sampling design	Timely information for management decisions

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