


Genomics

An Emerging Tool for Land Reclamation and Environmental Management

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HEMMERA

Outline

- Genomics 101
- Opportunities for Genomics
- Genomics in Action
  - eDNA
  - PRB’s

A Snapshot of Hemmera

250

Number of current staff

4

Number of regions we operate in

Lines of Business:

Planning and Management

- Environmental impact assessment
- Environmental monitoring
- Permitting and regulatory authorizations
- Wildlife and aquatic habitat and assessment

Site Assessment and Remediation

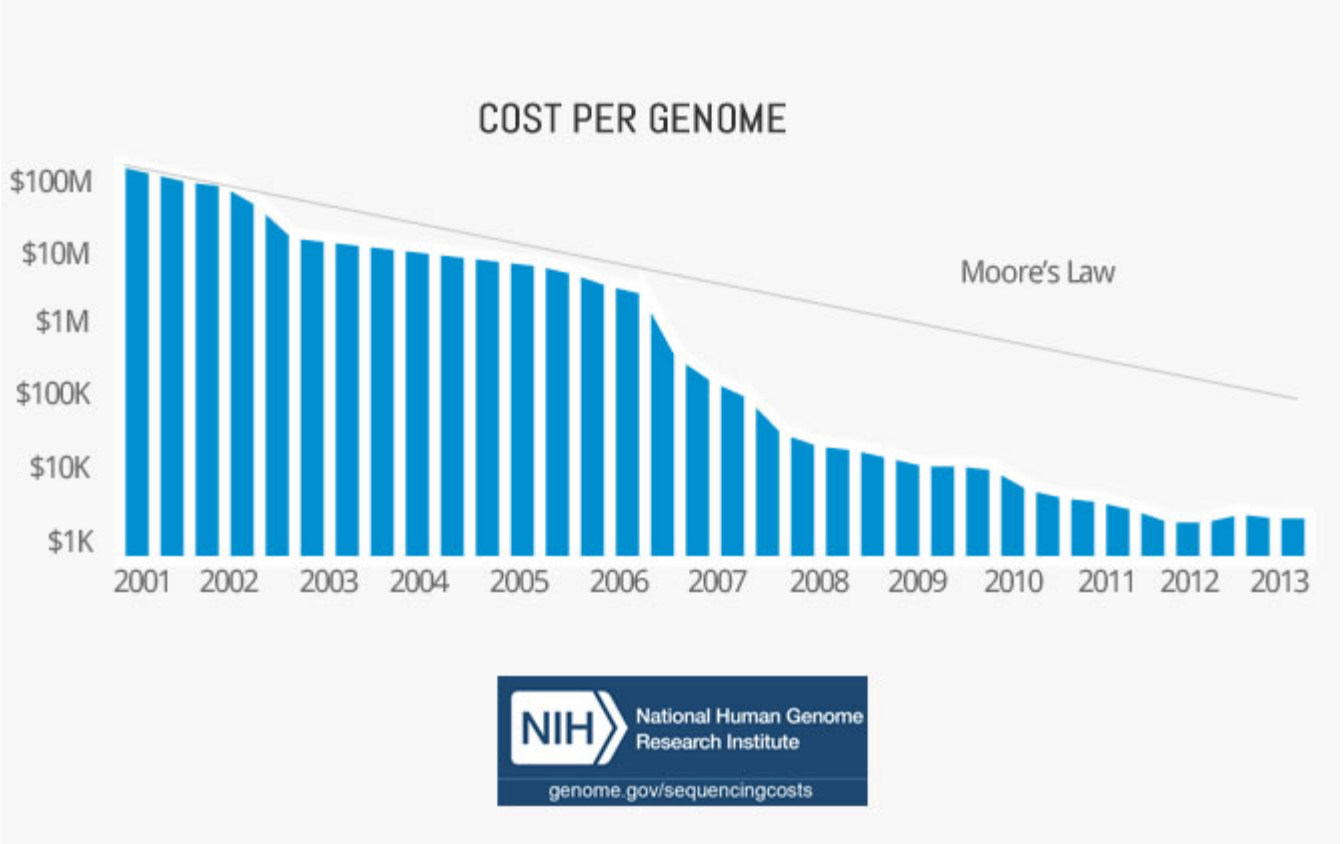
- Phase I and II Environmental Site Assessments
- Brownfield development
- Response planning, training, and facilitation
- Waste discharge authorizations and permits

Community Engagement and Social Sciences

- First Nations consultation and engagement
- First Nations negotiation and negotiation support
- Socio-economic baseline studies and effects assessments

Genomics 101

- Genome
- Genomics



Genomics as a tool

‘Pollution eating microbes’

- Certain microbes play a growing role in the clean-up of pollution
- Widely used in the treatment of contaminated soils and groundwater, and are being used increasingly in resource development and environmental management

The Environmental Challenge: Mine Wastewater

The Genomics Challenge

Global Landscape

- **Chile:** Metallurgical performance of industrial scale bio-heap-leaching monitored by ‘omics technologies
- **Netherlands:** 500 m^3 bio-reactor treating sulfate and zinc rich water monitored by genomics for 128 weeks. US: Commercial microarrays for investigating biogeochemical, ecological and environmental processes
- **Finland:** Simulated bioleaching of poly-metallic sulfide ore was monitored by genomics
- **China:** Extremely acidic tailings in Pb/Zn mine monitored by genomics
- **Canada:** Teck, Imperial Metals, Cameco, Shell, Chevron, Suncor, Syncrude... actively involved in proof of concept ‘omics projects

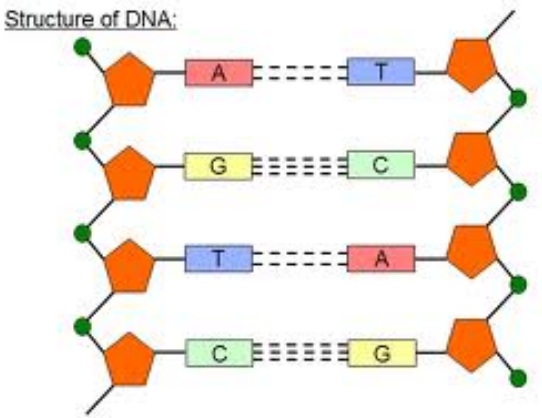
Case Studies

Environmental DNA as a Service Offering

What is eDNA

- **Environmental DNA (eDNA)**
  - naturally occurring genetic materials that can be collected from the environment
  - gametes, dead skin cells, feathers, hair, feces, urine, egg plasma, saliva

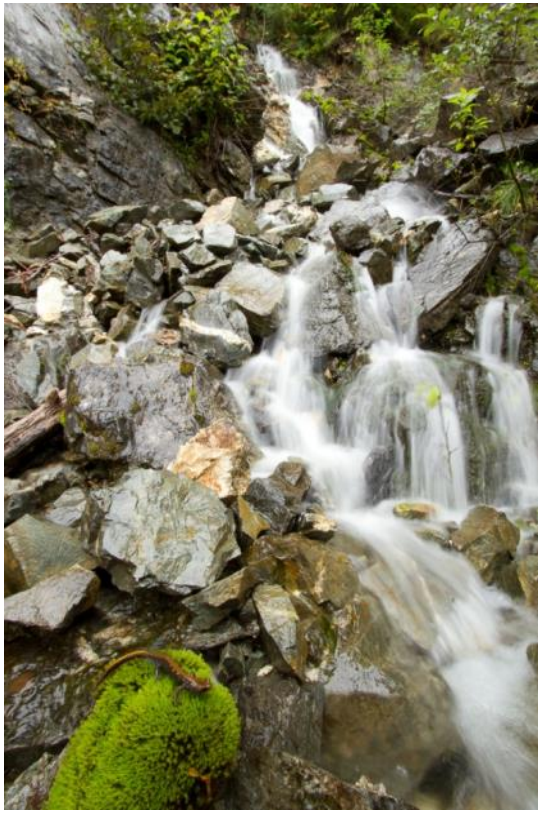
Primer and Probe Design



- A good primer will contain an inclusive consensus sequence that incorporates all within-species variability for a species in a well-known sequence of DNA.
- Primers need to incorporate the full range of genetic variation for the target species to avoid false negatives
- Primers need to incorporate the full range of genetic variation for closely related, co-occurring species to avoid false positives.
- Primers can be reviewed against sequences published in GenBank or against sequences obtained from tissue samples of target and co-occurring closely related species.

Project & Survey Design Considerations

Consider sampling requirements to ensure they're appropriate for the system you're sampling…



Project & Survey Design Considerations

Know the species' life history

Is there a permanently aquatic life history phase…

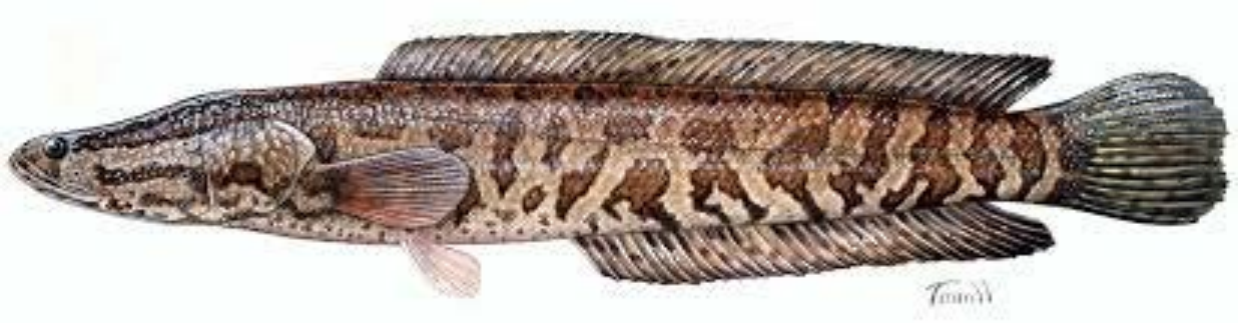
…or does your target taxa tadpole mature in three days, or 6 years???

Rationale & Efficacy

- More cost effective
- Reduced Type I & II errors
- eDNA methods will not transmit pathogens.
- eDNA doesn't disturb, harm or kill both target and non-target taxa

Key Applications

- Early detection and monitoring (Presence/Not-detected) for management for:
  - Species of regulatory concern
  - Pathogens
  - Early detection of invasive species
  - Confirming eradication of invasive species



Pacific Water Shrew (*Sorex bendirii)*

List	Status
BC CDC	Red listed
COSEWIC	Endangered
SARA	Endangered S.1

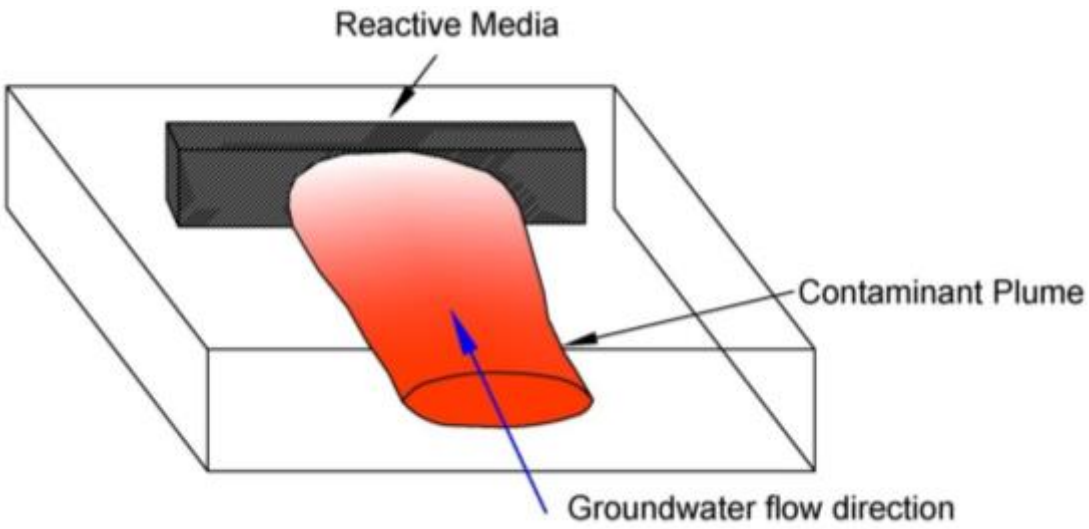
- Pacific water shrew occurs in the BC lower mainland region
- Conventional methods are lethal and have a very low capture rate. Identification is also challenging.
- We have four active projects underway

Permeable Reactive Barriers

PRBs are like cakes…

How does a PRB work?

Clean Groundwater beyond PRB



Metal Sufides
+ Water
+ Oxygen