

Haliburton Highlands Land Trust & Abbey Gardens

Event Package: Salamanders
Season: Summer



Haliburton
Highlands
Land Trust

Research Paper: The Role of Salamanders Across Global Ecosystems

Introduction

Salamanders, amongst the Order Caudata, compose the Class Amphibia, which also includes frogs (Order Anura) and caecilians (Order Gymnophiona) (Wake, 2009). Globally, there are more than 400 species, 59 genera, and 10 families of salamanders (Davic and Welsh 2004; Zug *et al.* 2001). Widely distributed across North America, South America, Europe, and temperate East Asia, these ancient vertebrates have been approximated to have existed since the Paleozoic times, evolving extensive ecological diversification over the last 150 to 200 million years (Wake, 2009; Davic and Welsh 2004; Duellman, 1999). Although they comprise a high abundance in both terrestrial and aquatic habitats, further study is needed to define the role salamanders have within the environment (Keitzer and Goforth 2013; Davic and Welsh 2004). Salamanders have often been reported as bio-indicator species, since they synthesize information about the environmental health of an ecosystem (Davic and Welsh 2004; Willson and Dorcas 2003). This is due to the fact that salamanders rely strongly on the environment for temperature regulation and respiration (Pearce and Venier 2009). Whilst considering the importance of salamanders in the maintenance of ecosystem function, it becomes evident that salamanders are an essential component of nature.

Life History

Like all amphibians, salamanders are biphasic and have two different growth phases throughout their full life cycle (Belasen *et al.* 2013; Greenwald *et al.* 2009; Rittenhouse *et al.* 2004). Upon emerging from eggs, salamanders spend between the first weeks to months of their lives in an aquatic, larval stage (Wake, 2009). Eventually, salamanders will develop into their terrestrial, adult form, surviving another several years (Wake, 2009). In their adult form, salamanders can be recognized by their generalized vertebrate morphology (Wake, 2009). It should be noted that life history traits might vary between species as well. For instance, some members of the Salamandridae family give birth to larvae or fully metamorphosed juveniles rather than eggs (Wake, 2009). Salamanders are also ectotherms, meaning they rely on the external environment to regulate their body temperatures (Wake, 2009). This dependence on their surroundings often limits salamanders to a relatively small distribution within the ecosystems where they live (Wake, 2009). The uniqueness of salamanders' life history, and all amphibians alike, highlights the distinct role that they have within both aquatic and terrestrial ecosystems.

Preferred Habitat

Due to the biphasic nature of salamanders' life cycle, these organisms occupy several different forms of habitat. Salamanders in their aquatic larval stage are often the most common amphibians of North American headwater streams (Keitzer and Goforth 2013). In addition, adult salamanders are often extremely

populous in primarily forested and grassland environments (Davic and Welsh 2004). Within these terrestrial environments, salamanders are often found in moist forest leaf litter, tree canopies, talus slopes, and seasonally inundated pools (Davic and Welsh 2004). Salamanders themselves are considered to be ecosystem engineers since they alter soil properties by creating underground burrows (Davic and Welsh 2004). Due to the wide range of salamander habitat, the finer distinctions of preferable habitat features are only starting to be understood at both the individual and population level (Belasen *et al.* 2013). Factors that may influence salamander abundance in a particular region are: the presence of leaf litter, small mammal burrows, coarse woody debris, moisture, humidity, and temperature (Belasen *et al.* 2013; Faccio, 2003). Larger scale impacts that affect salamander populations' distribution are the proximity to bodies of water and forest composition (Belasen *et al.* 2013; Renaldo *et al.* 2011; Burne and Griffin 2005). For this reason, approximately 35 percent of salamander genera of North America prefer to reside in riparian ecotones between aquatic and terrestrial environments (Davic and Welsh 2004; Krzysik, 1998). The forest successional stage, forest type, and soil type also affect salamander abundance, whereby salamanders prefer old growth and deciduous stands with alkaline, wet soil (Belasen *et al.* 2013; Renaldo *et al.* 2011; Pearce and Venier 2009; Davic and Welsh 2004). By studying salamanders' preferred habitat, will contribute to a greater understanding of this organism as a whole and aid in maintaining their longevity in future years.

Interspecies Interactions

Salamanders are also embedded in the environment through interspecies interactions. This is due to the fact that salamanders regulate food webs and act as a component in the trophic hierarchy of ecosystems (Davic and Welsh 2004). Salamanders themselves are obligate carnivores with a polyphagous feeding strategy, therefore they are able to feed on several different food sources yet rely on meat as their main source of energy (Davic and Welsh 2004; Petranka 1998; Zug *et al.* 2001). In their aquatic larval stage, salamanders are able to act as abundant consumers within fishless streams (Keitzer and Goforth 2013). Often stream-dwelling salamanders are the main predators of aquatic macroinvertebrates (Keitzer and Goforth 2013). As such, an alteration in salamander population size could alter invertebrate abundance (Keitzer and Goforth 2013). Within their adult form, salamanders consume invertebrates, vertebrates, and aerial insects (Davic and Welsh 2004). Several predators also rely on salamanders as a high-energy food source including: birds, mammals, snakes, fishes, frogs, crayfish, predatory insects, and even other salamanders (Davic and Welsh 2004; Petranka, 1998). Due to this predatory pressure, salamanders have evolved defense strategies such as nocturnal habits, mimicry, and toxic skin excretions (Davic and Welsh 2004). Therefore it is certain that salamanders possess a key role in the maintenance of ecosystem function through predatory-prey interactions.

Population Threats

Although salamanders are reportedly very common amphibians in several different habitats, salamander populations are still threatened by anthropogenic activity and are declining globally (Davic and Welsh 2004). Namely, most scientists consider habitat loss and degradation to be the most significant threat to salamander populations (Willson and Dorcas 2003; Alford and Richards 1999). Appropriate salamander habitat is commonly lost due to human activities such as: habitat alteration, toxic chemical spillage, the loss of wetlands, and the introduction of exotic species (Davic and Welsh 2004). Road mortality is another large threat to the amphibian community as a whole (Mazerolle, 2004). Since salamanders often encounter roads during their movements between breeding, summering, or hibernation sites, differences in traffic intensity can lead to drastic increases in mortality rates (Mazerolle, 2004; Fahrig *et al.* 1995). Lastly, a threat to salamander populations that is only starting to be studied is climate change (Wake, 2009). Since salamanders are bio-indicators and as ectotherms are extremely sensitive to changes in temperature and moisture within their environment, it is predicted that climate change will have a profound effect on these organisms (Wake, 2009). Whilst considering the anthropogenic cause of these threats to salamander populations, it is clear that humans must strive to minimize habitat degradation to maintain salamander abundance throughout global ecosystems.

Conclusion

By studying the role of salamanders in the environment, it is clear that these amphibians are important members within numerous habitats. As bio-indicators of healthy ecosystems, not only are scientists able to monitor salamanders as a tool for predicting future environmental integrity, perhaps one could strive to preserve salamander populations in order to ensure the maintenance of natural ecosystems (Pearce and Venier 2009). The study of salamander populations synthesizes information on several healthy habitat features such as: invertebrate populations, microclimates, leaf litter, soil condition, and coarse woody debris (Pearce and Venier 2009; Welsh and Droege 2001). Yet as salamander populations decline globally due to human causes, it seems evident that more should be done to understand and protect these significant organisms. However, since salamanders have survived since the before the Paleozoic time, perhaps these amphibians have proven their resilience throughout previous environmental change (Wake, 2009). All in all, it remains abundantly clear that salamanders are an essential component within global ecosystems and have a significant role within the environment.

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Research Summary

- ❖ Salamander populations are declining globally
- ❖ Salamanders are bio-indicators
 - They are sensitive to their environment in order to respire and regulate temperature
 - They rely on numerous structural components of a healthy ecosystem to find adequate habitat (i.e. coarse woody debris, leaf litter, old-growth tree stands, lack of human disturbance)
- ❖ Salamanders are ecosystem engineers
 - They physically alter the environment where they live by creating underground burrows, thus changing soil properties
- ❖ Salamanders belong to the order Amphibia (along with frogs, toads, and caecilians)

- ❖ They are often mistaken for lizards, who belong to the order Reptilia, however what sets them apart is that they lack scales and claws, and instead have soft, moist skin
 - Also, salamander eggs are gelatinous or in a gelatinous mass which needs to be kept moist or wet
 - Whereas reptile eggs (lizard) are harder shelled (rubbery, not like a chicken, but are protected from desiccation)
- ❖ Salamanders exist in their juvenile form as aquatic tad-pole like larvae
 - They prefer to live this life phase within wetlands and headwater streams
- ❖ Later they develop into adult, terrestrial vertebrates
 - They prefer to live this life phase in mature, deciduous forests or grasslands
- ❖ Both juvenile and adult salamanders are carnivorous, relying on invertebrates and insects, however larger salamanders may choose to eat fish, frogs, and even other salamanders
- ❖ Salamanders are typically nocturnal
 - During the day they can be found under leaf litter or decomposing woody debris

Proposed Event Logistics

Duration of Event

Time	Activity	
	Abbey Gardens	HHLT
10:00 am	-Meet Group at Abbey Gardens Food Hub (or tent if used for a large group) -Register and sign in (on registration/sign in) sheet and receive name tag	-Meet Group at Dahl Forest Trail Head -Register on sign in sheet and receive name tag
10:15 am	-Learn safety protocols and best practices for monitoring salamanders -Listen to a brief talk on the importance of salamanders and how to find them	-Learn safety protocols and best practices for monitoring salamanders -Listen to a brief talk on the importance of salamanders and how to find them
10:30 am	-Begin hike through Abbey Gardens, whilst following the map highlighting the proper route -Gather at stops 1-5 to discuss salamander talking points at designated areas	-Begin hike through Dahl, whilst following the map highlighting the proper route -Gather at stops 1-5 to discuss salamander talking points at designated areas

11:30 pm	-Continue loop and begin hiking back towards the Abbey Gardens main office	-Continue loop and begin hiking back towards the Dahl Forest trail head
12:00 pm	-Compare field notes, photos, and sightings for the day -Fill out a feedback card about today's event	-Compare field notes, photos, and sightings for the day -Fill out a feedback card about today's event

Date Range

Terrestrial, adult salamanders prefer to reside in vernal pools that remain wet from spring until mid-summer. As such the proposed date range for this summer event is early, within the month of June.

Length of Walk

The hike is suggested to take approximately two hours cumulatively, since some visitors may spend a lot of time searching for salamanders on site. At Abbey Gardens, the walk will follow the extended loop trail, which is approximately 3.6 kilometers. At Dahl Forest, the walk will follow several trails, totaling approximately 5 kilometers.

What to Bring

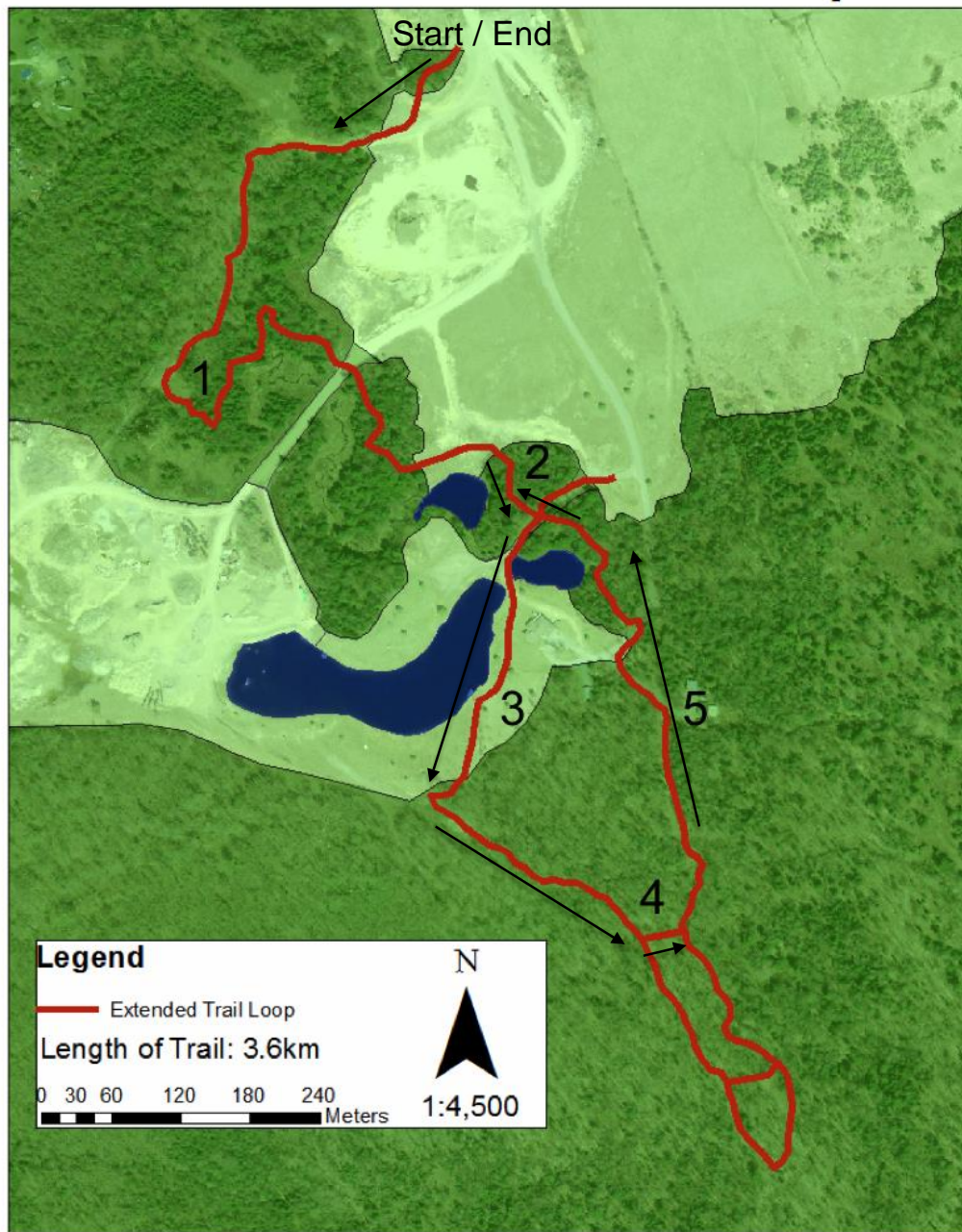
- Field notebook and pencil
- A means to tell the time
- Proper footwear (i.e. hiking boots)
- Appropriate clothing for the weather (i.e. rain gear, hats, sunscreen, bugspray)
- Water/drink
- Lunch
- Camera (optional)
- GPS or compass (optional)
- Binoculars (optional)

Suggested Walking Loops

Abbey Gardens

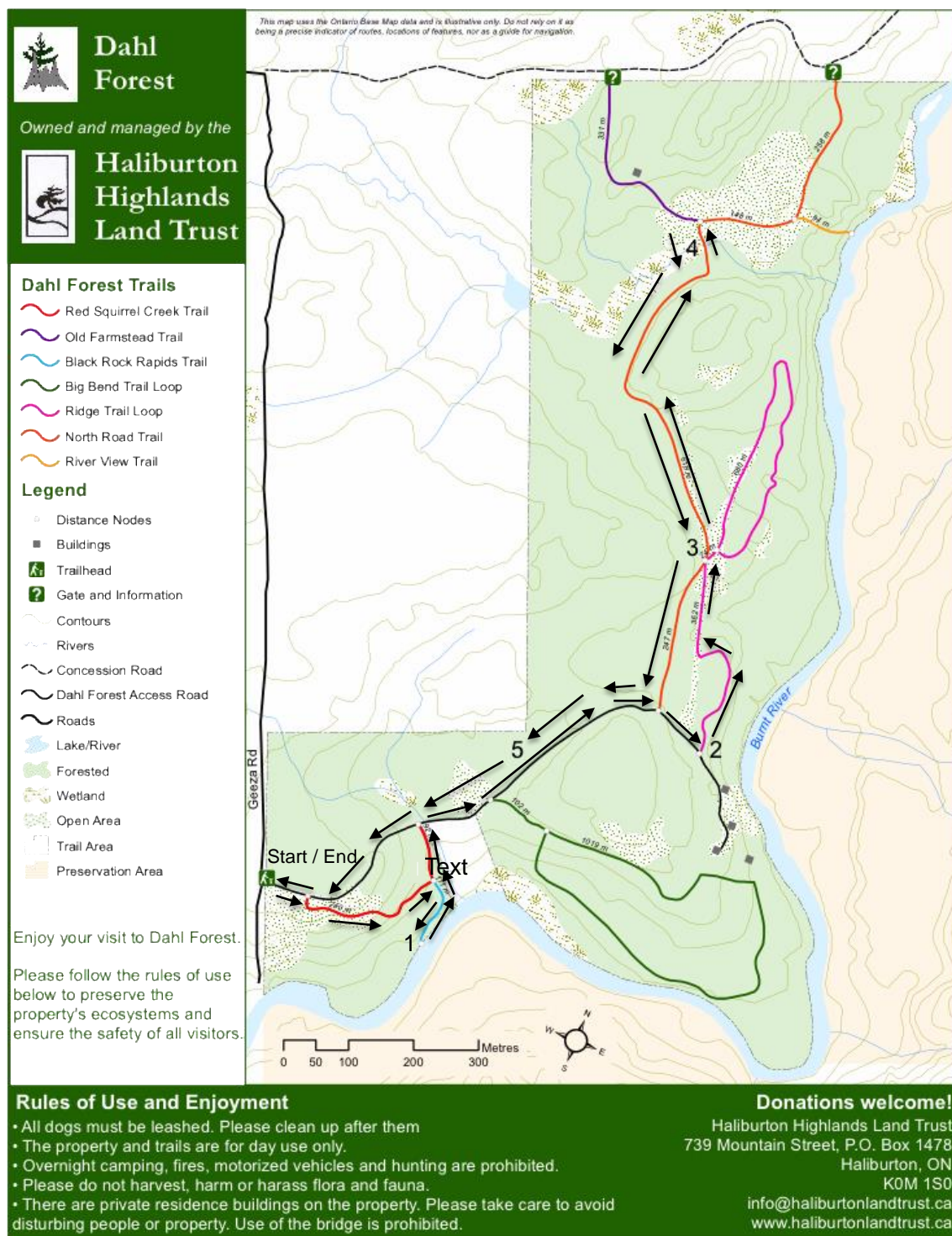
See map on next page.

Extended Trail Loop



*Note: map numbers correspond to the stops listed below. Event leaders should bring corresponding photos and talking points to each stop. Set-up prior to the event is only required at stop #5. The other locations may be re-arranged to accommodate where certain salamanders are likely to be found during the event.

Dahl Forest



*Note: map numbers correspond to the stops listed below. Event leaders should bring corresponding photos and talking points to each stop. Set-up prior to the event is only required at stop #5. The other locations may be re-arranged to accommodate where certain salamanders are likely to be found during the event.

Props

Stop #1: Salamanders with Spots (*Ambystomatidae* family)

- ❖ Blue-spotted Salamander (*Ambystoma laterale*)



- ❖ Spotted Salamander (*Ambystoma maculatum*)



Talking Points:

- These salamanders belong to the family *Ambystomatidae*, also known as mole salamanders
- These salamanders spend most of their time underground to remain moist, typically in small mammal burrows
- To avoid drying out, mole salamanders migrate to their breeding grounds (shallow woodland pools) before the ice has even melted
- They are active during the night, especially after heavy rains
- The blue-spotted salamander is the smallest mole salamander

Stop #2: Ontario's Only 'Lonely' Newt

- ❖ Eastern Newt (*Notophthalmus viridescens*)- adult phase



- ❖ Eastern Newt (*Notophthalmus viridescens*)- juvenile (red eft) phase



Talking Points:

- The Eastern newt is the only species in this salamander family
- Newts have tough and bumpy skin in their immature phase (named the eft phase)
- Their life cycles do not follow the same pattern as a typical salamander: they spend one to three years in the terrestrial eft stage and then returns to the water as a fully aquatic adult
- As an adult, the newt still has its lungs and must gulp for air at the surface to breathe in its aquatic habitat
- Newts live in ponds and bays where there are no predatory fish, and have bright colouring during their immature phase to warn predators away

Stop #3: Learning about the Lungless (*Plethodontidae* family)

- ❖ Eastern Red-backed Salamander (*Plethodon cinereus*)



- ❖ Four-toed Salamander (*Hemidactylium scutatum*)



❖ Northern Two-lined Salamander (*Eurycea bislineata*)



Talking Points:

- As adults, these salamanders lack lungs and most lack gills
- Instead of breathing through lungs or gills, they absorb oxygen through their skin and the mucous membrane in their mouth
- They live in a range of moist habitats (forests, springs, caves, and streams)
- Many lungless salamanders can shed their tails to distract predators

Stop #4: Mudpuppies

❖ Mudpuppy (*Necturus maculosus*)



Talking Points:

- Also referred to as waterdogs
- Mudpuppies are fully aquatic and have permanent external gills, therefore they would not be found along the event's walking route
- Many people may catch mudpuppies during fishing practices, however it is suggested that they be released since they are an essential component of our aquatic habitats
 - Mudpuppies are often found ice fishing, however if observed citizens should report their sighting to Ontario Nature
- Mudpuppies hide in thick vegetation in rivers and lakes, emerging at night to feed on tadpoles, fish, crayfish, and other invertebrates
- Mudpuppies are Canada's largest salamanders

Added Components

Stop #5: Cover Boards

Additional cover boards could be placed in old growth, deciduous stands at each of the sites. Preferably the location would be in a moist area, like beside a vernal pool for instance. This would allow event attendees to identify salamanders together in one setting. Untreated wood should be used that is 12 by 12 inches. The boards may either be placed in a transect or grouped in an array. The more boards that are placed at the site, the higher the likelihood of

finding a salamander. These boards should be placed at the site at least four months prior to sampling.

Installation Steps:

1. Remove the leaf litter from the site
2. The soil should be leveled so that the entire board is in contact with the ground
3. Upon returning to the site, the boards may simply be lifted to observe the salamanders seeking cover there.



Tips for Monitoring Salamanders

- “Take only photos, leave only footprints.”
- Do not handle salamanders
 - Salamanders have highly absorbent skin that could absorb toxins from your hands (i.e. bug spray, sunscreen)
- When checking under coarse woody debris or cover boards, be sure to place logs and cover boards gently back onto the ground to avoid crushing salamanders
- Do not veer too far off the suggested trails to avoid getting lost

- It is suggested that event organizers venture to the sites the day before the event to scout where certain salamanders are likely to be on site

Useful Links

Identification

http://www.ontarionature.org/protect/species/reptiles_and_amphibians/

<http://www.natureconservancy.ca/en/where-we-work/ontario/our-work/salamanders.html?referrer=https://www.google.ca/>

<http://www.discoverlife.org/mp/20q?guide=Salamanders>

<http://www.carcnet.ca/english/amphibians/tour/province/amphON.php>

Cover Boards

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/cwt/guidance/4422b.pdf

<http://faculty.camosun.ca/annettedehalt/files/2011/02/Salamander-Boards.pdf>

Feedback from Today's Event

What did you enjoy?

What would you change in the future?

