Development of Salt Pools in Restored Salt Marshes in the Bay of Fundy

A Case Study

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Introduction to the project

- Two established salt marshes, two impacted marshes

- Impacted marshes 5 years old (Fall 2010)
  - Two fields with breached dikes in the process of becoming marshes
  - Lower elevation

- Reference marshes ~60 years old

- Interested in pool restoration

Salt Pools

- Pools that retain water year round
- Initiated by disturbances or erosion
- Very sheltered
- Abundant food
- Important microhabitat in salt marshes
  - Important fish nursery ground
    - Mummichogs have been known to enter a marsh with gut <10% full, leave on average 80% full (Rosa and Odum, 1987).
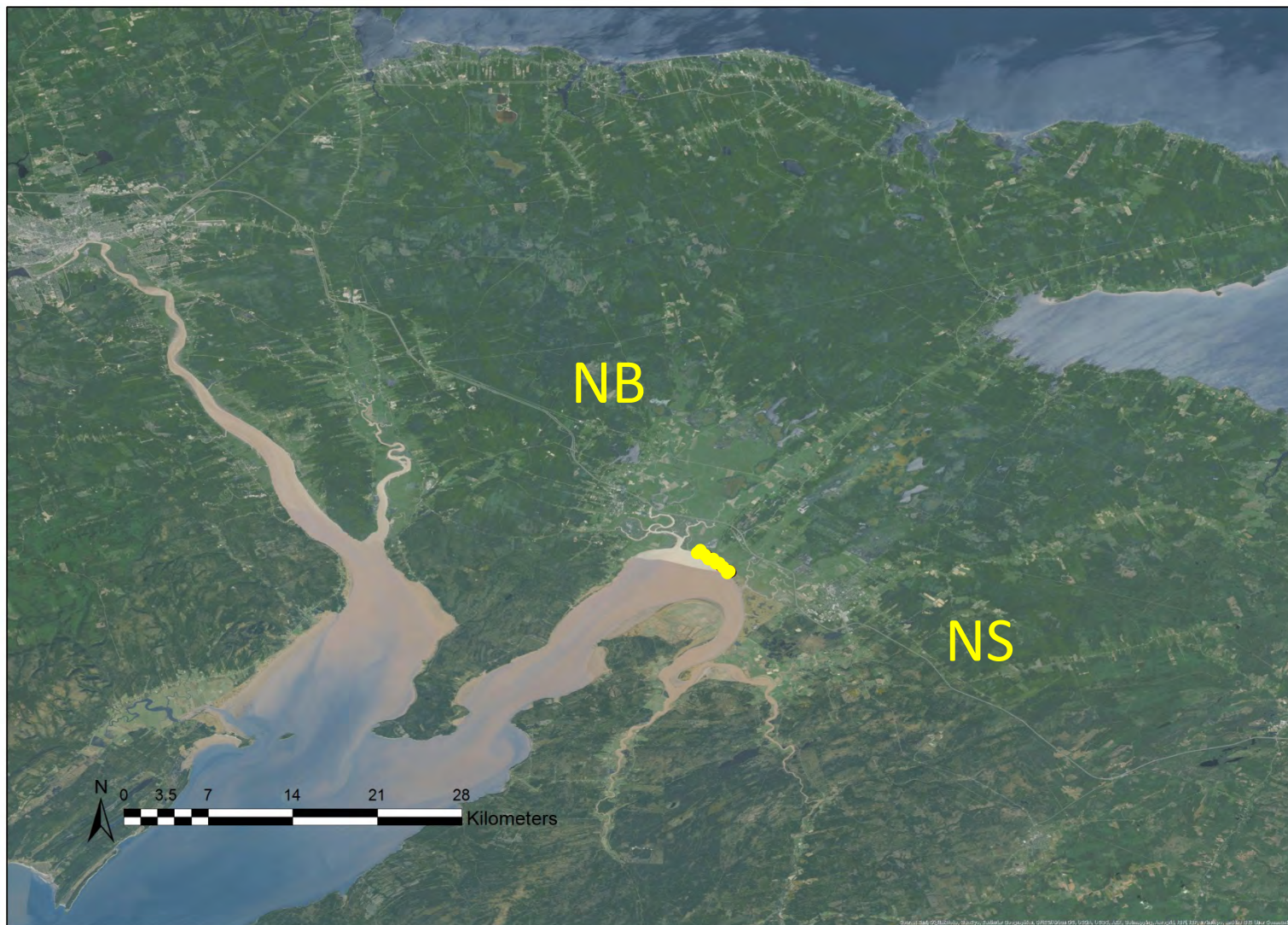 - Aquatic invertebrate habitat

Research questions

- How do salt pools in a restored marsh compare to those in a reference marsh?
  - Biotically
  - Abiotically
- What features are associated with any differences?
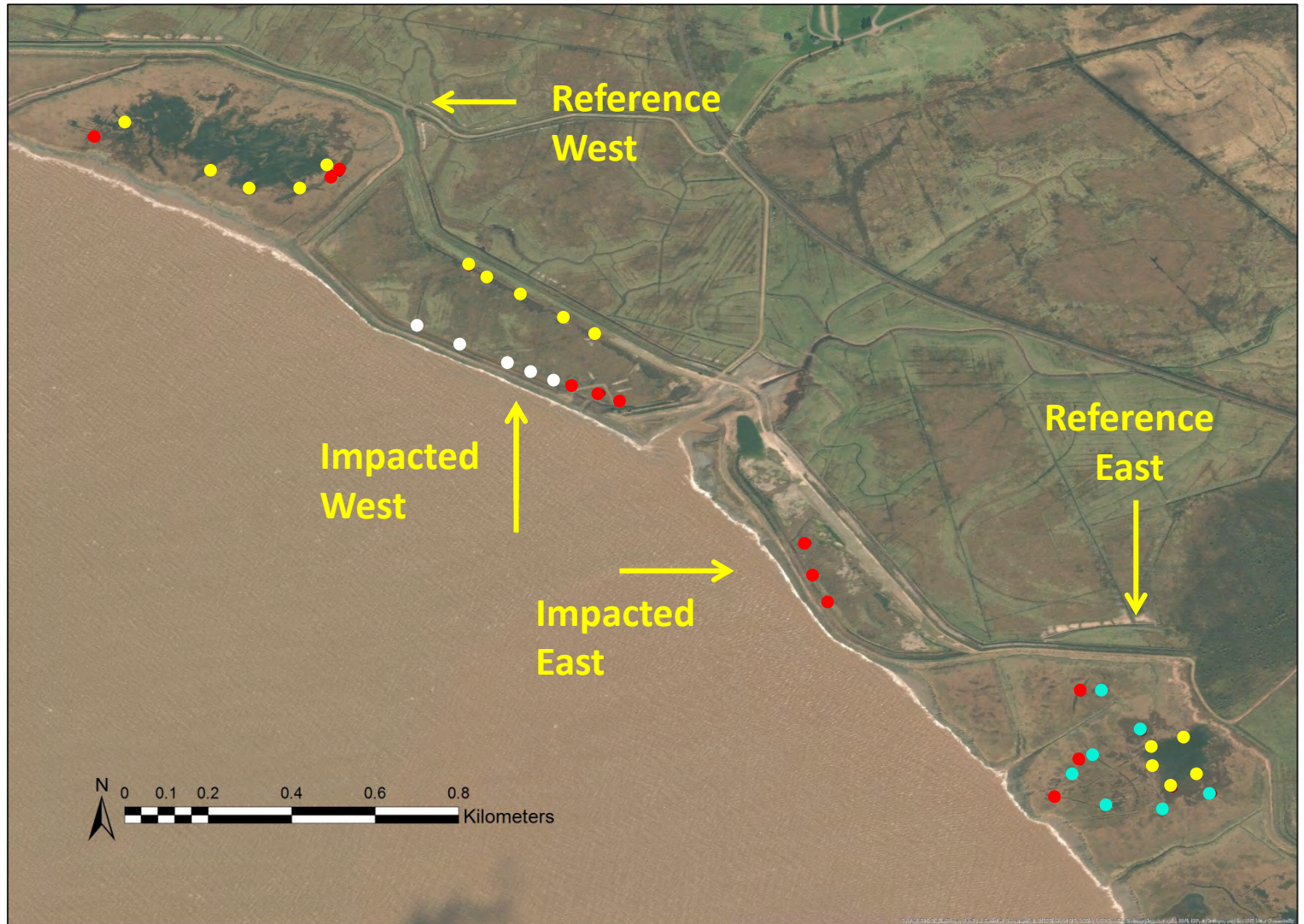- When might salt pools become fully restored?

Aulac Salt Marsh Pool Sample Sites

NB

NS

N

0   3.5   7   14   21   28
                                    Kilometers

Aulac Salt Marsh Pool Sample Sites

Methods

- Monthly sampling
  - June, July, August
  - 2011-2015
- 1 large pool per site
  - IW, IE, RW, RE
- 3 small pools per site
  - IW, IE, RW, RE
  - 2015 only

Impacted West

Reference East

Methods

- Abiotic measurements
  - pH
  - DO mg/L (dissolved oxygen)
  - Salinity
  - Temperature
  - Sediment penetrability

Methods

- Biotic measurements
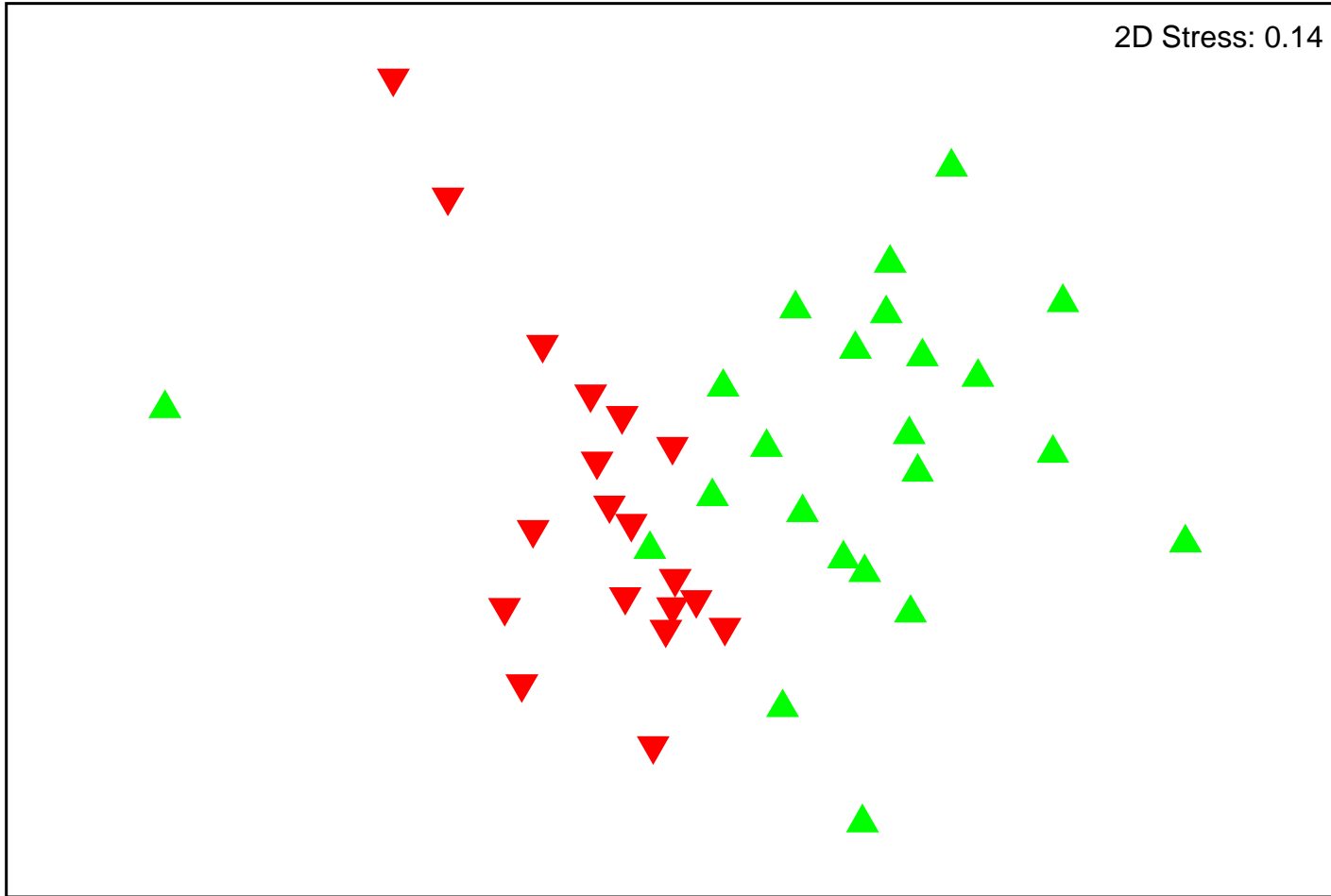 - Minnow traps
  - Invertebrate activity traps

Flickr.com

Darwinwasright.org

Results-Abiotics

Normalise
Resemblance: D1 Euclidean distance

Symbol = Average per site for a given month

Results-Abiotics

Normalise
Resemblance: D1 Euclidean distance

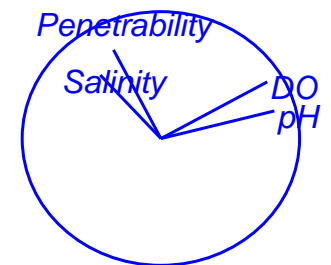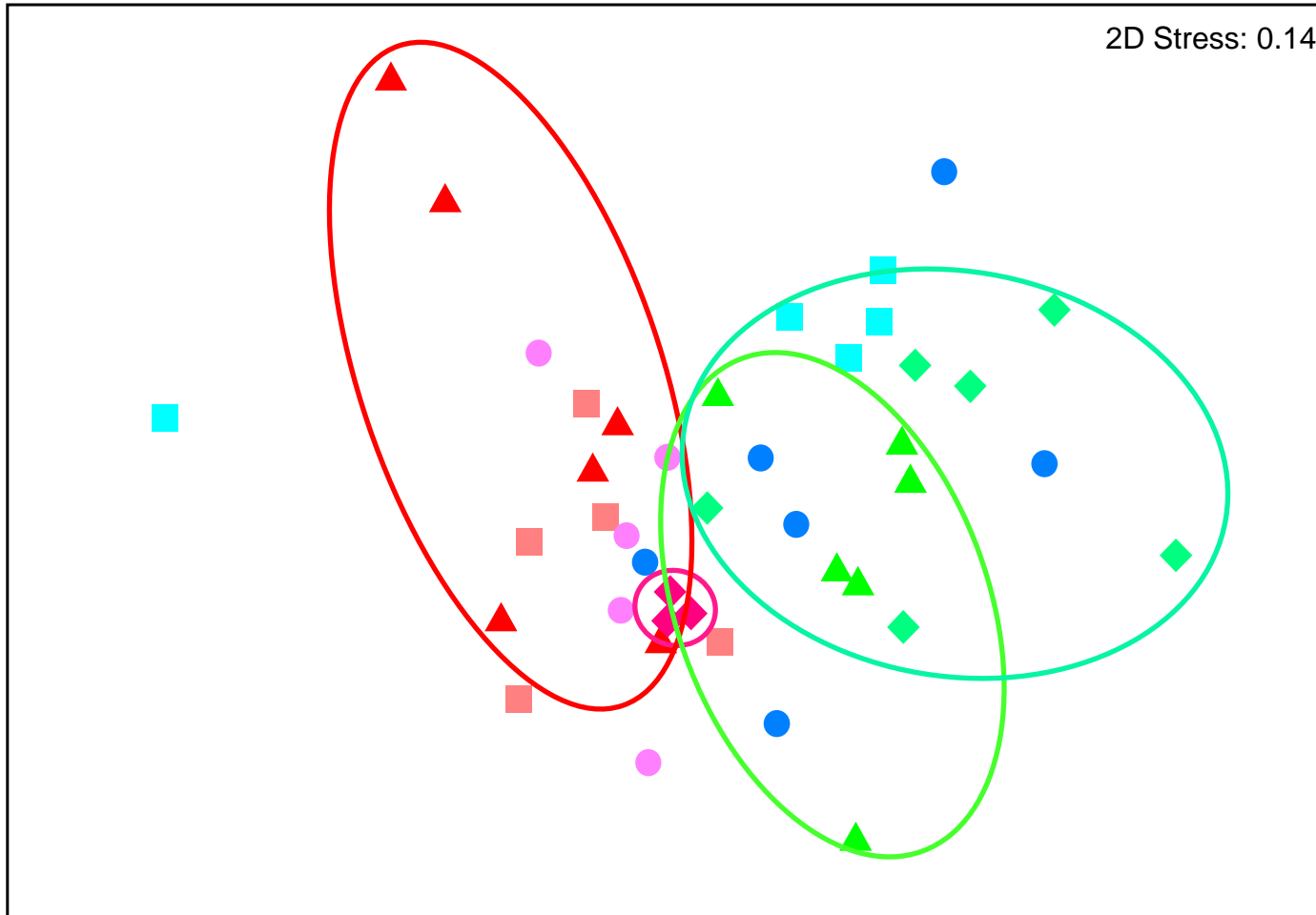Symbol = Average per site for a given month

Results-Abiotics

Normalise
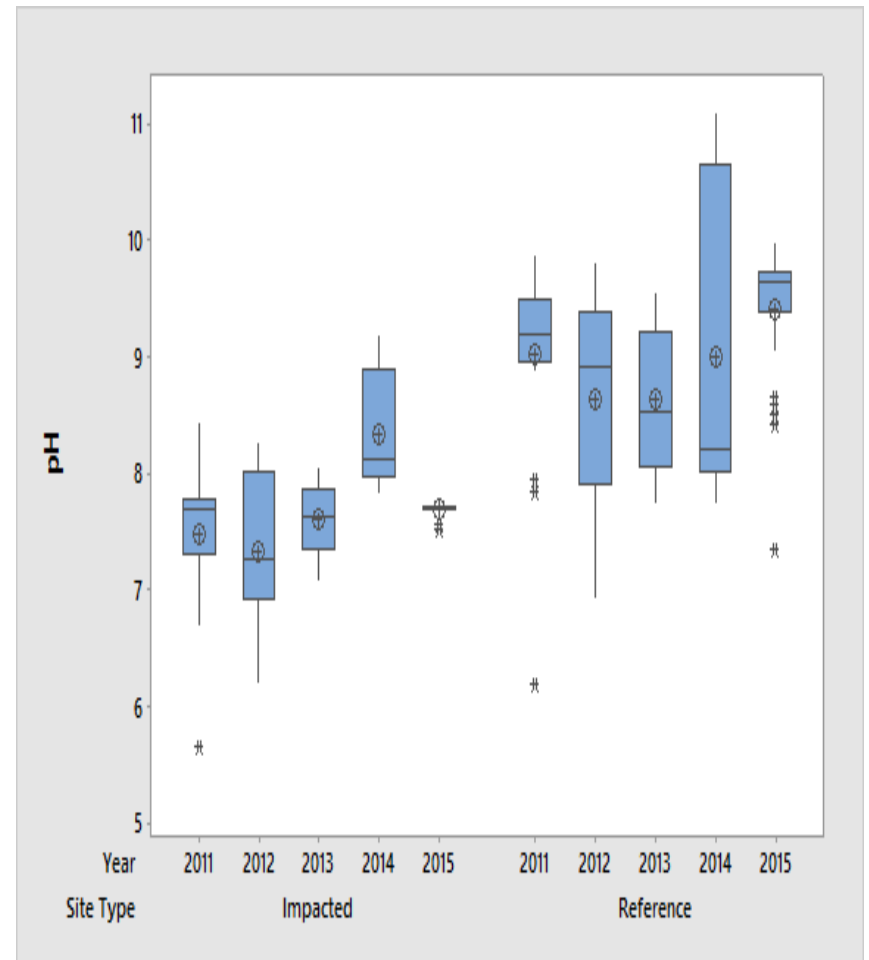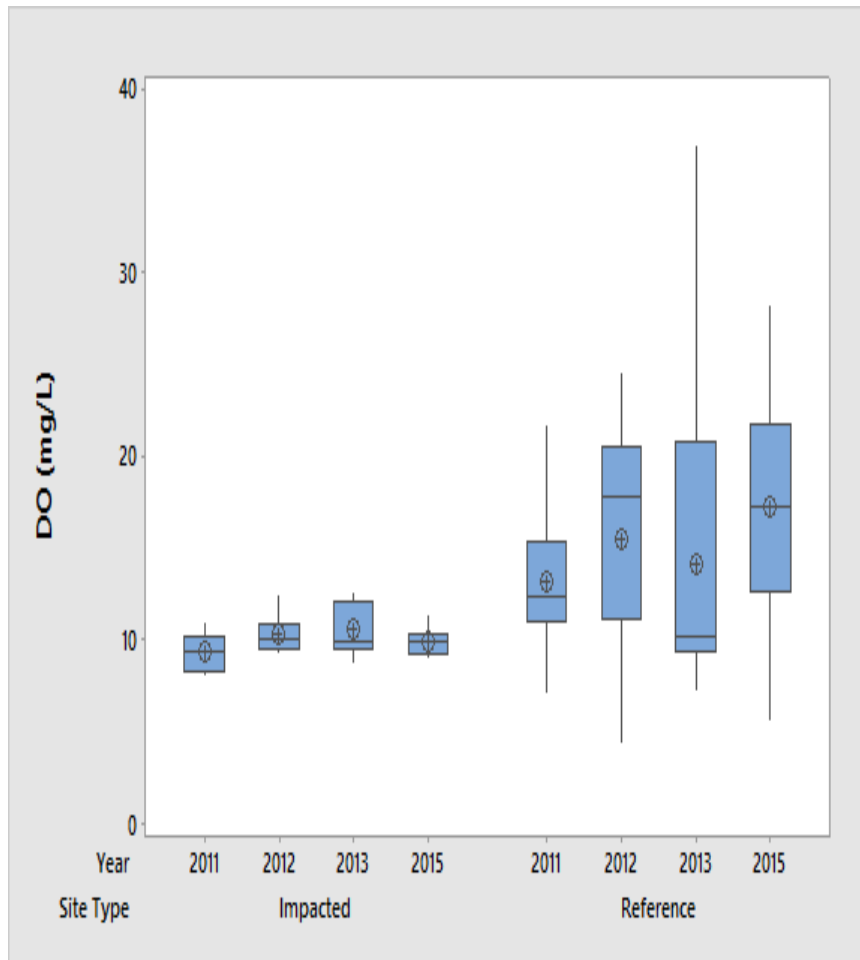Resemblance: D1 Euclidean distance

2D Stress: 0.14

Year SiteType
- ▲ 2011 Reference
- ▲ 2011 Impacted
- ■ 2012 Reference
- ■ 2012 Impacted
- ● 2013 Reference
- ● 2013 Impacted
- ◆ 2015 Reference
- ◆ 2015 Impacted

Penetrability
Salinity
DO
pH

Symbol = Average per site for a given month
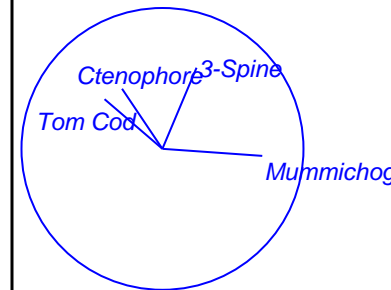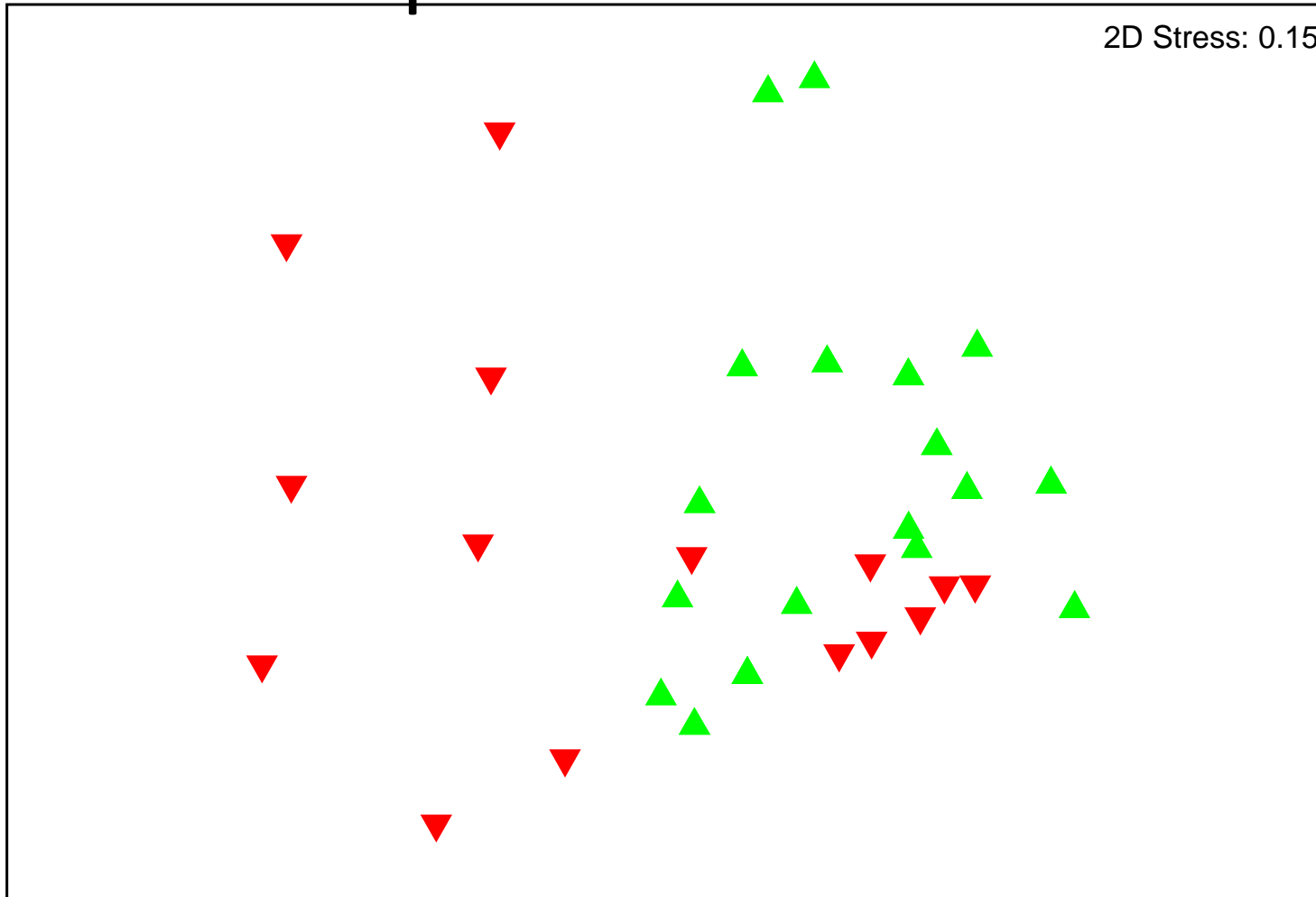
Results-Abiotics

Results- Minnow Traps

Resemblance: S17 Bray Curtis similarity (+d)
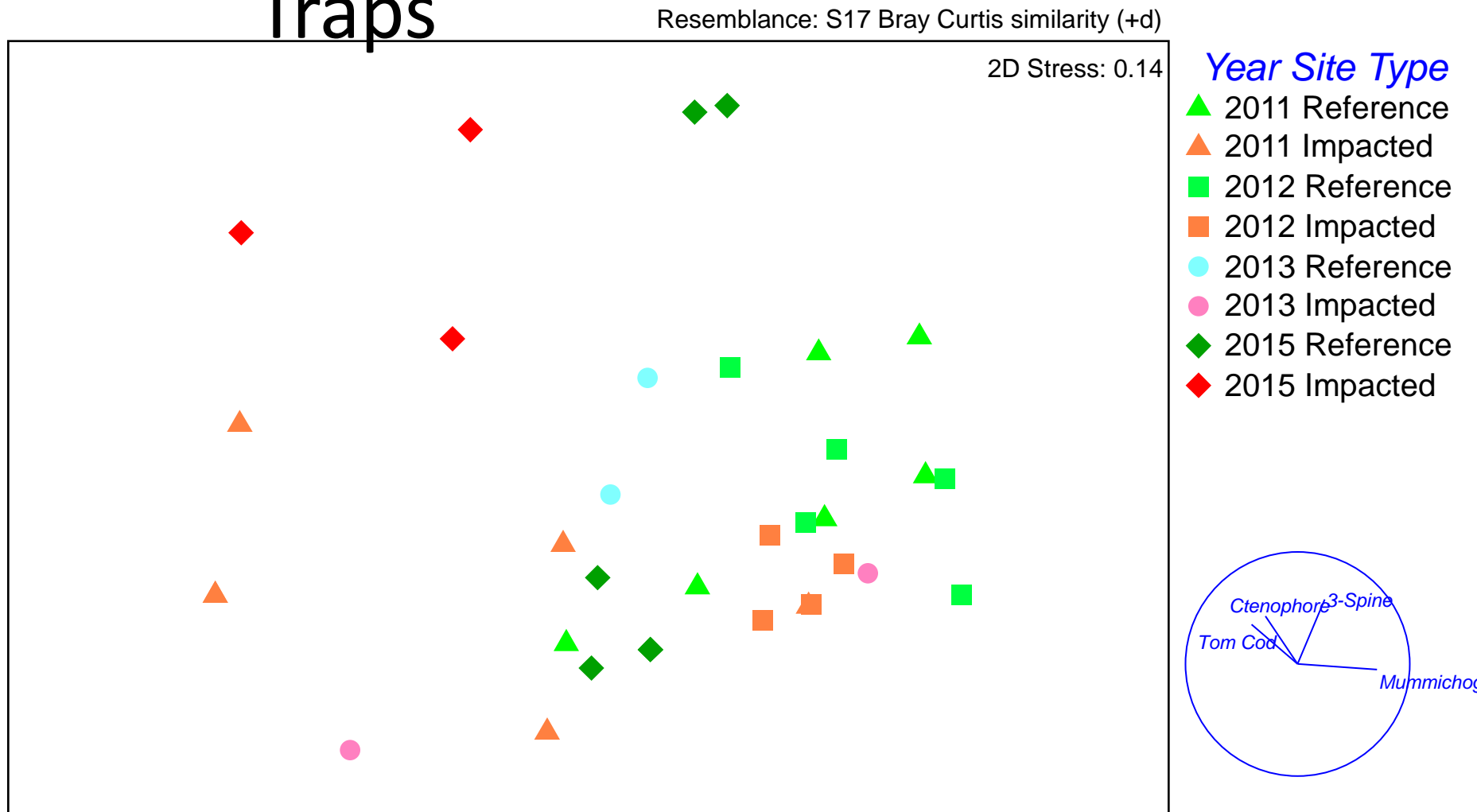
2D Stress: 0.15
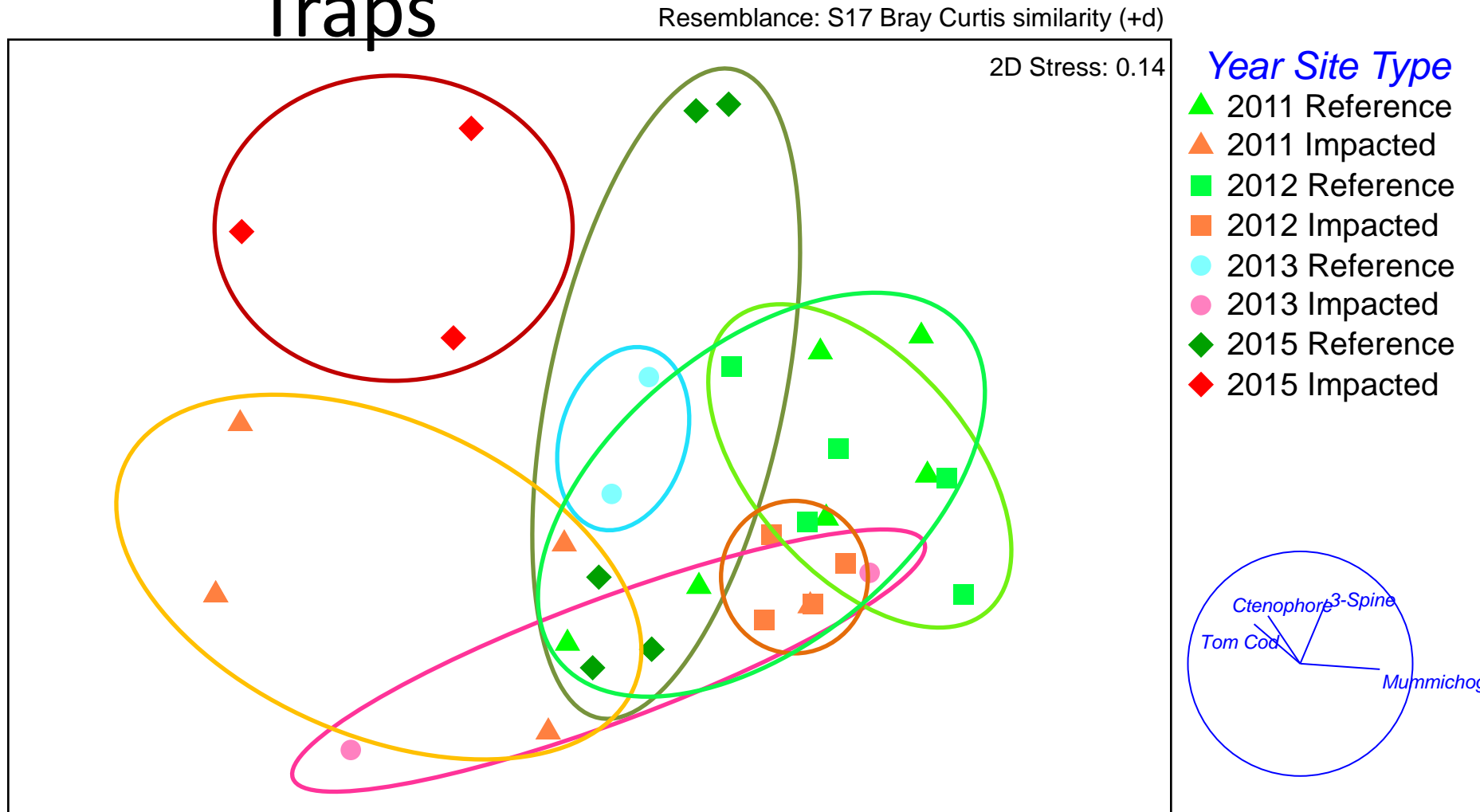
SiteType
▲ Reference
▼ Impacted

Ctenophore 3-Spine

Tom Cod

Mummichog

Results- Minnow Traps

Symbol = Average per site for a given month

Results- Minnow Traps

Resemblance: S17 Bray Curtis similarity (+d)

2D Stress: 0.14

Year Site Type
- ▲ 2011 Reference
- ▲ 2011 Impacted
- ■ 2012 Reference
- ■ 2012 Impacted
- ● 2013 Reference
- ● 2013 Impacted
- ◆ 2015 Reference
- ◆ 2015 Impacted

Ctenophore *3-Spine*
Tom Cod
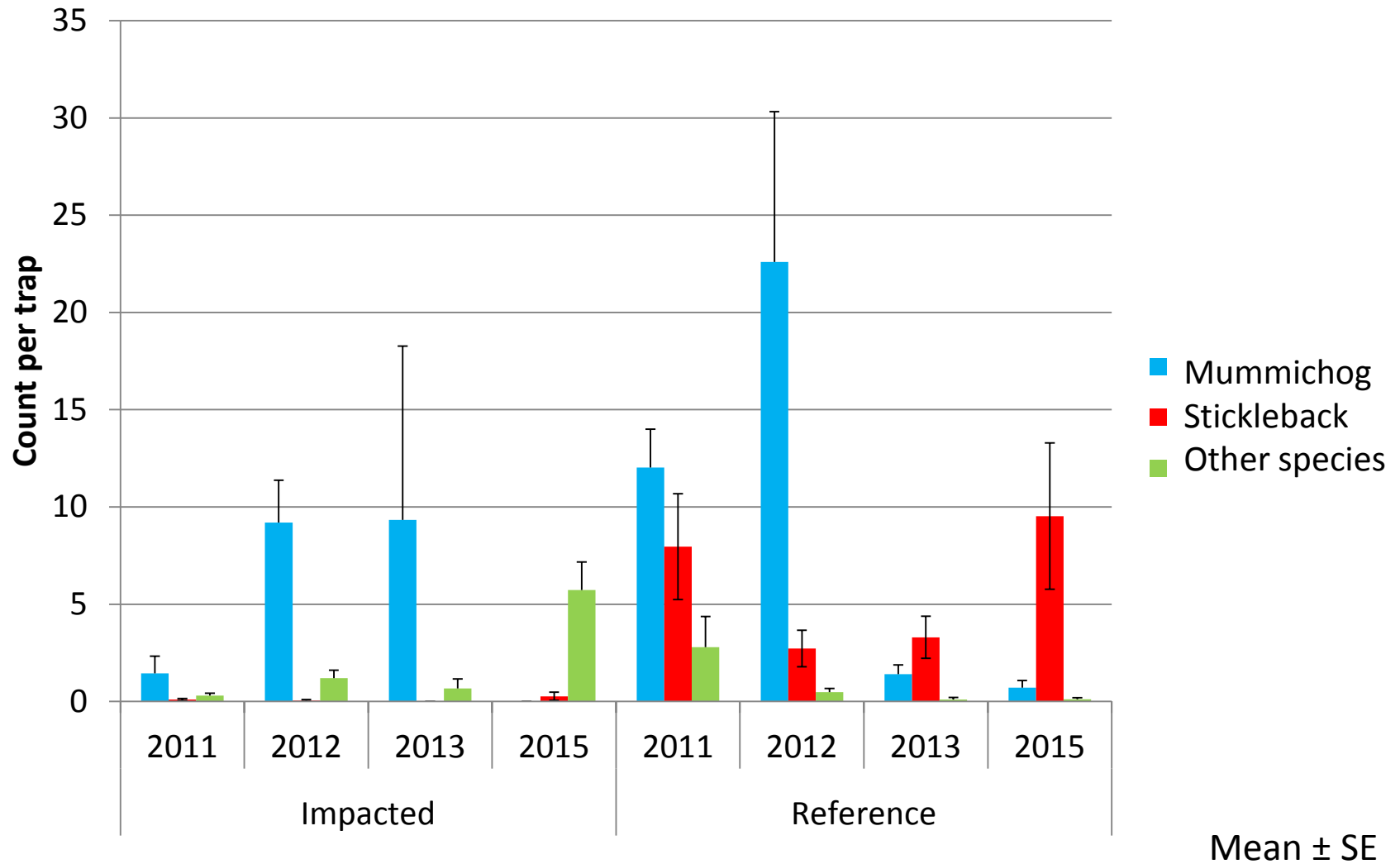*Mummichog*

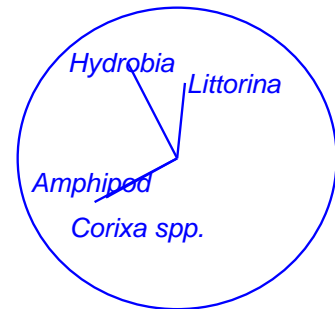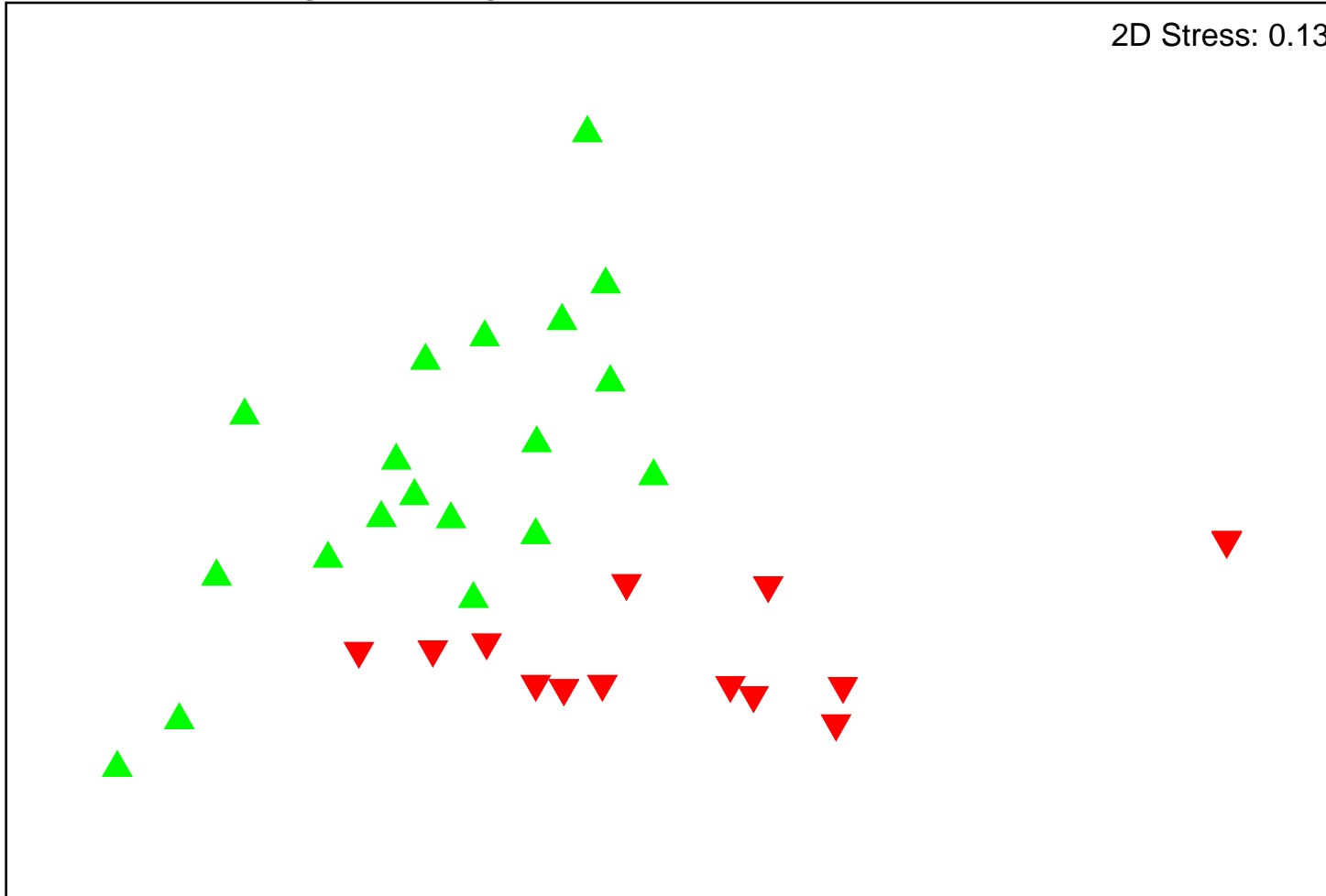Symbol = Average per site for a given month

Results- Minnow Traps

Mean ± SE

Results- Invertebrate Activity Traps

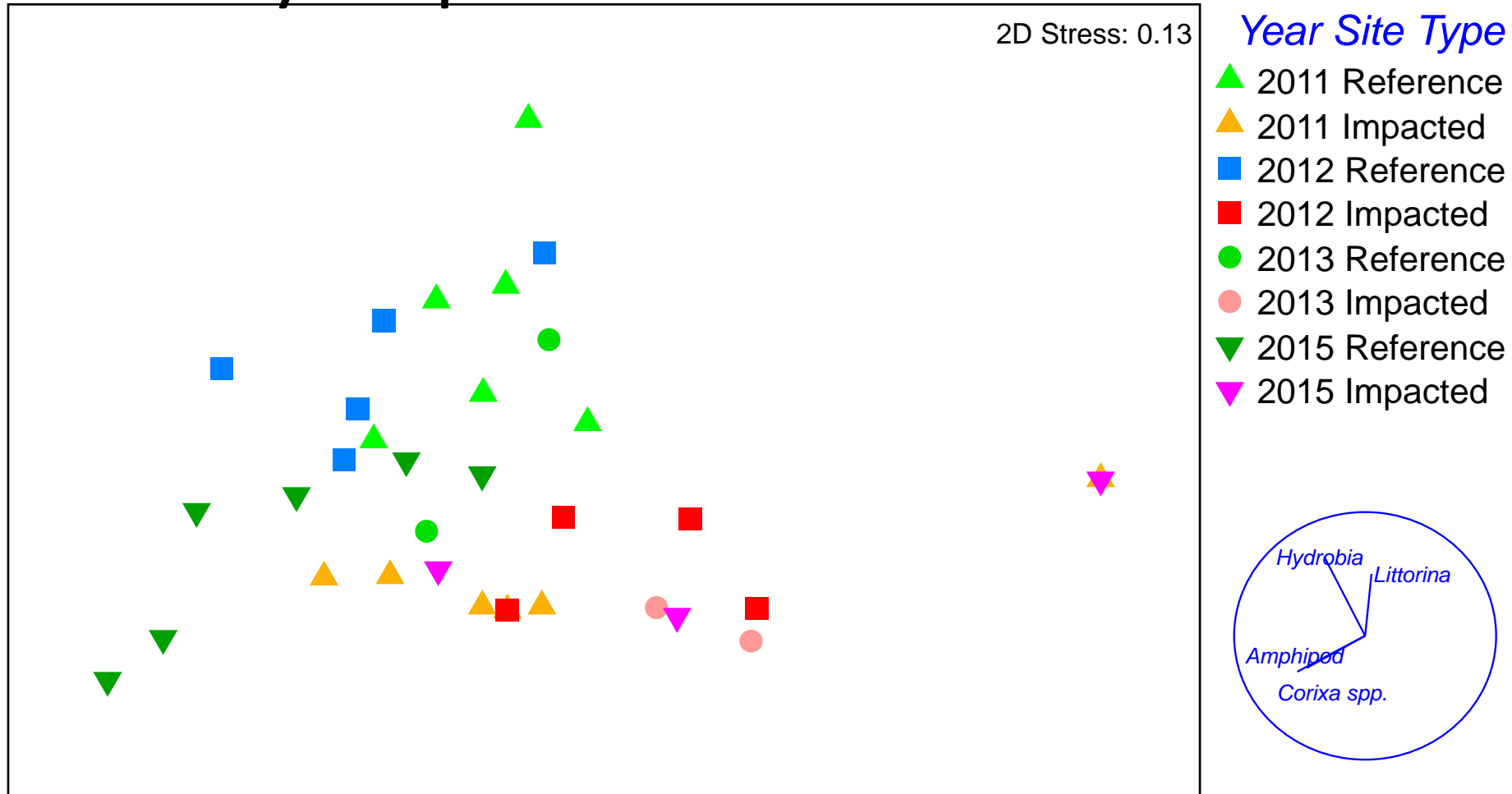Resemblance: S17 Bray Curtis similarity (+d)

2D Stress: 0.13

SiteType
▲ Reference
▼ Impacted

Hydrobia *Littorina*
Amphipod
Corixa spp.

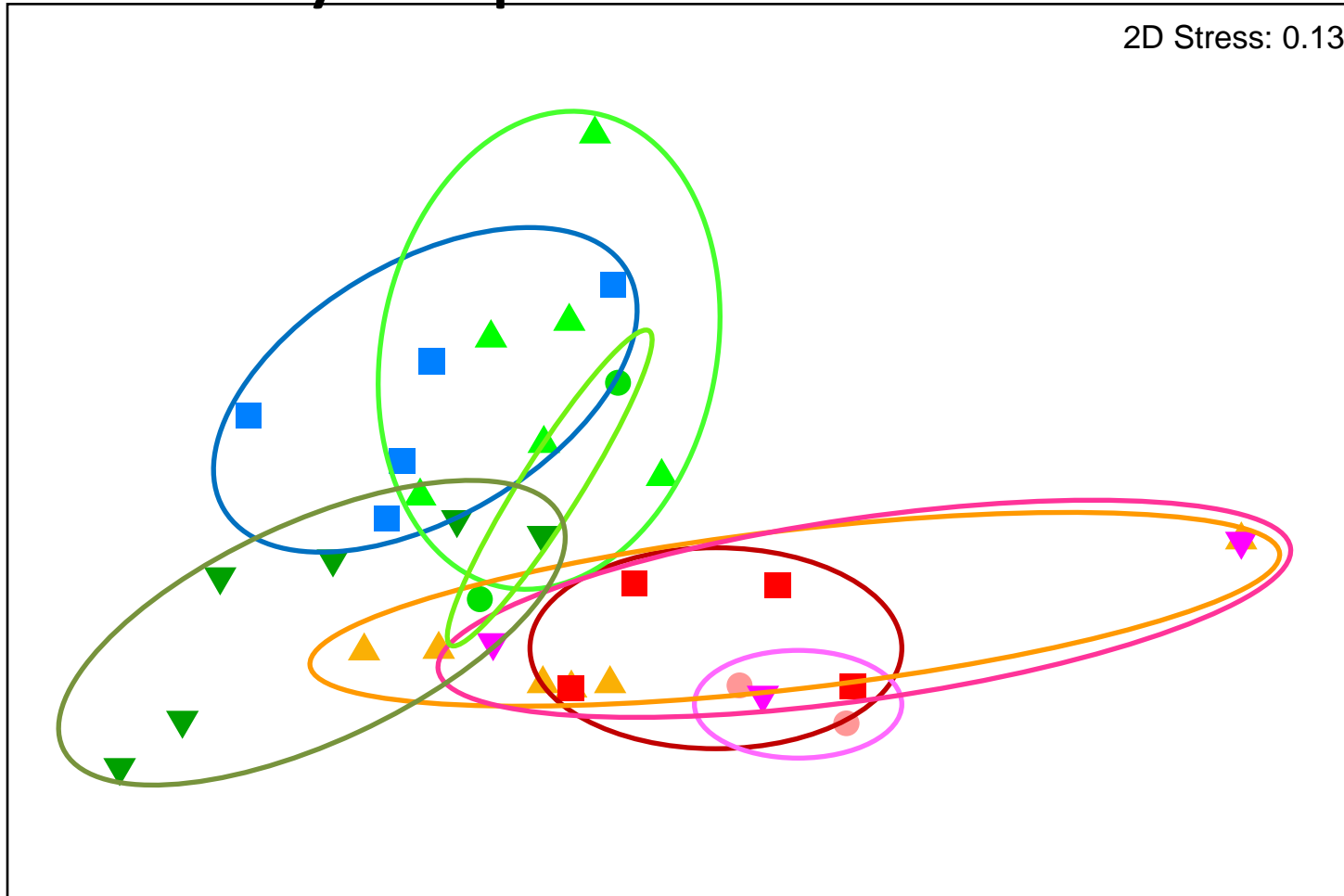# Results- Invertebrate Activity Traps

Resemblance: S17 Bray Curtis similarity (+d)

Symbol = Average per site for a given month

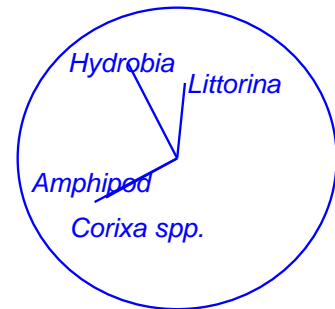# Results- Invertebrate Activity Traps

Resemblance: S17 Bray Curtis similarity (+d)

Symbol = Average per site for a given month
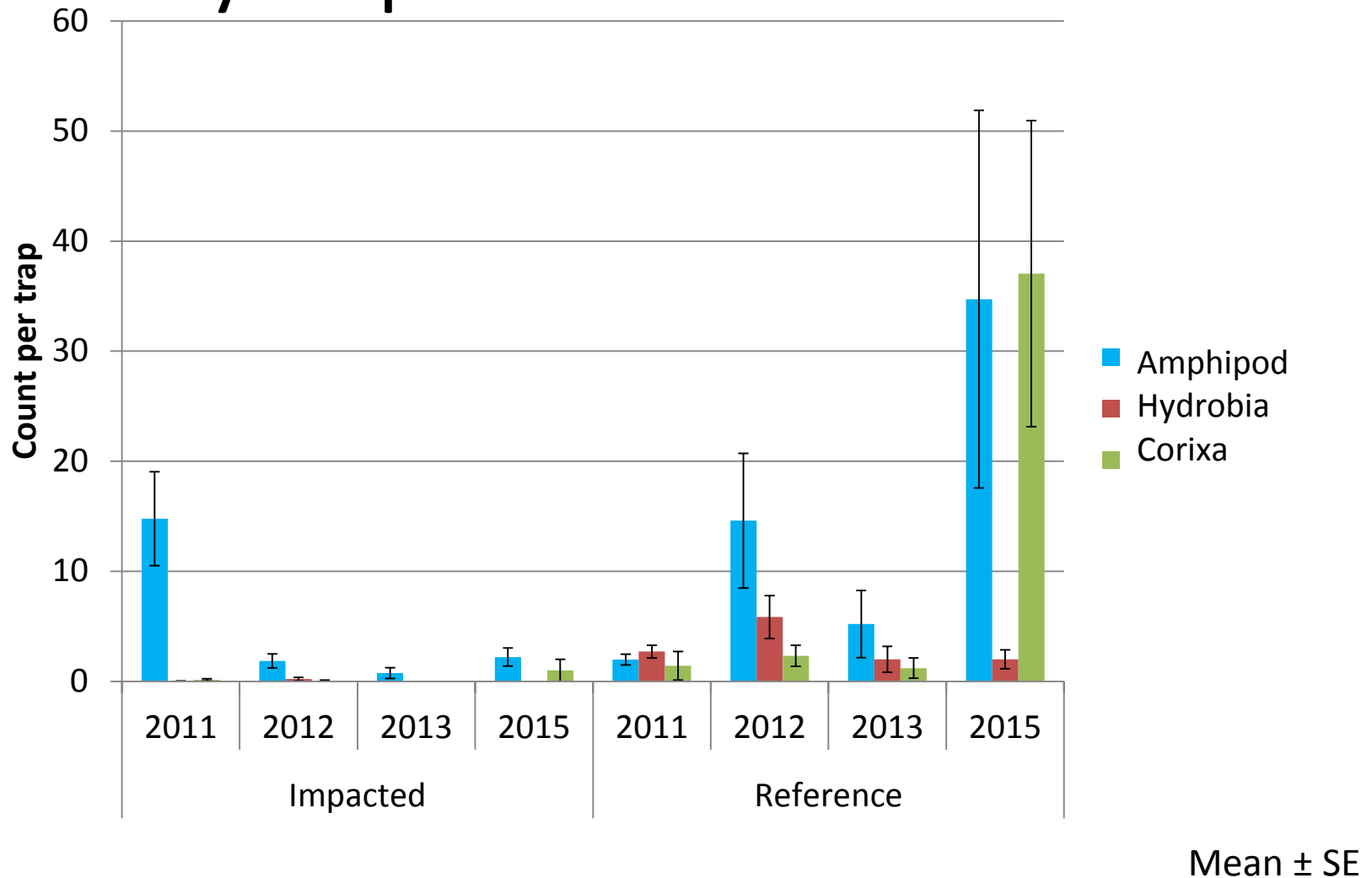
Results- Invertebrate Activity Traps

Mean ± SE

Conclusions

- Are we approaching the reference condition?
  - Abiotics of large pools still significantly different
  - Minnow traps significantly different in 2015, but not in 2012 and 2013
  - Activity traps not significantly different since 2013
- Aspects to watch
  - Large pool minnow traps
  - Appearance of algae and plants in impacted pools

Questions?

Acknowledgments:

Results

Small Pool Abiotics

Normalise
Resemblance: D1 Euclidean distance

2D Stress: 0.13

SiteType Month

▲ June Reference
▲ June Impacted
■ July Reference
■ July Impacted
● August Reference
● August Impacted

Penetrability

DO

pH

Salinity

Results
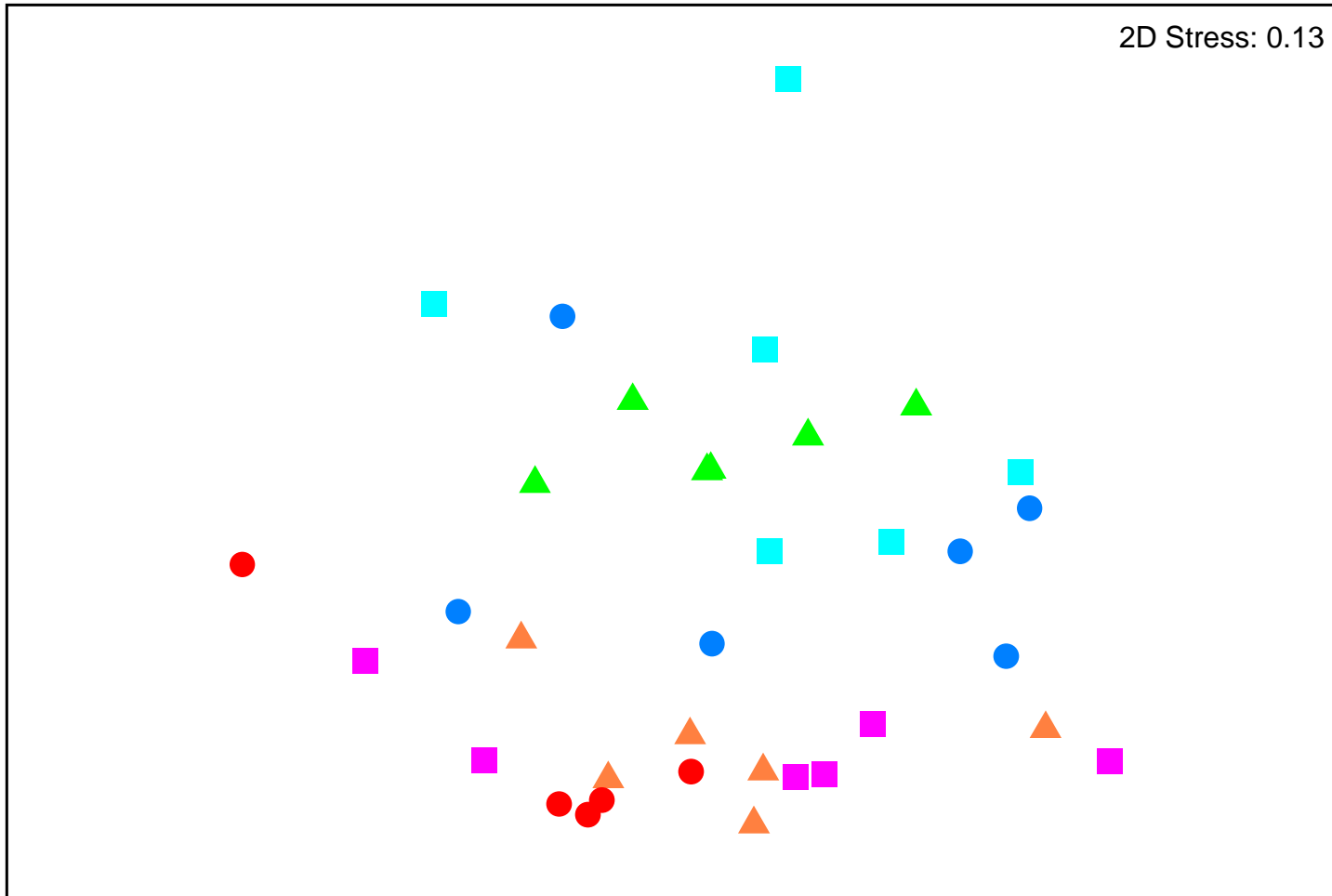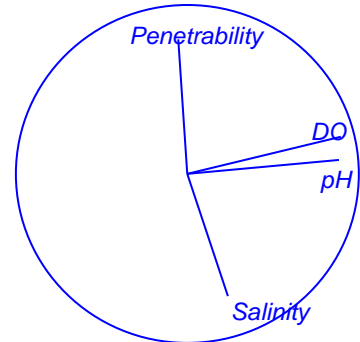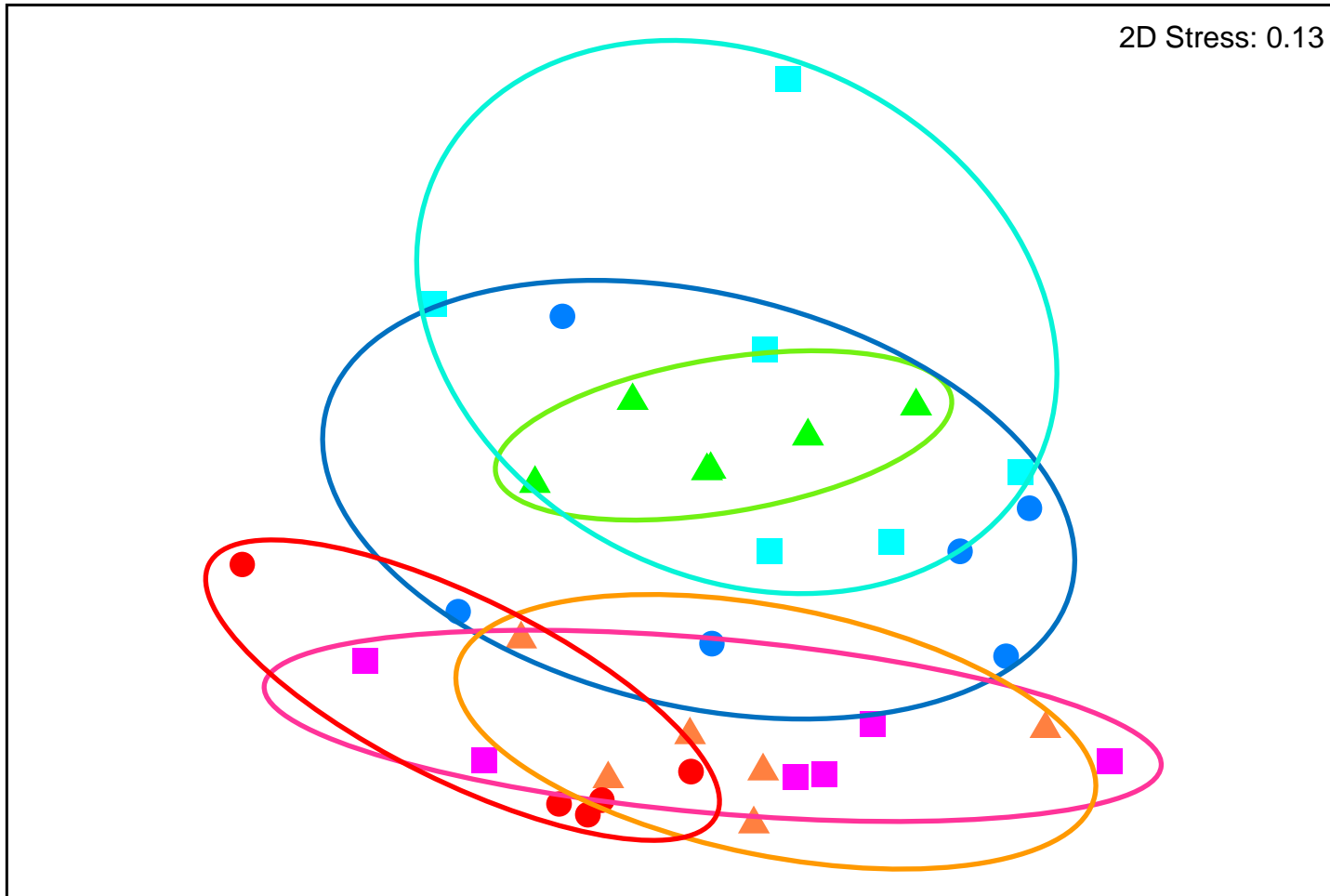
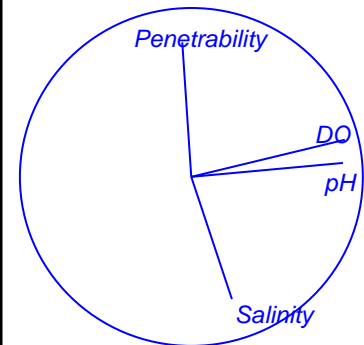## Small Pool Abiotics

Normalise
Resemblance: D1 Euclidean distance

2D Stress: 0.13

SiteType Month
- ▲ June Reference
- ▲ June Impacted
- ■ July Reference
- ■ July Impacted
- ● August Reference
- ● August Impacted

Penetrability
DO
pH
Salinity

Results

Small Pool Biotia-2015

Transform: Presence/absence
Resemblance: S17 Bray Curtis similarity (+d)

2D Stress: 0.01

Month SiteType

▲ June Reference

▼ June Impacted

■ July Impacted

◆ August Reference

● August Impacted
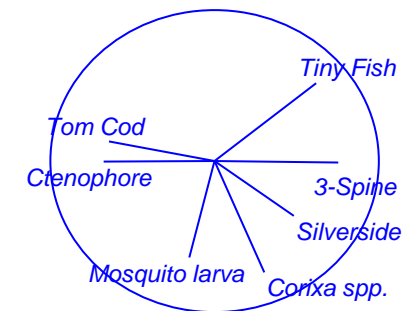
Results

Small Pools Biota- 2015
Transform: Presence/absence
Resemblance: S17 Bray Curtis similarity (+d)

2D Stress: 0.09

Month SiteType
- ▲ June Reference
- ■ July Impacted
- ◆ August Reference
- ● August Impacted

Tiny Fish

Tom Cod

Ctenophore

3-Spine

Silverside

Mosquito larva
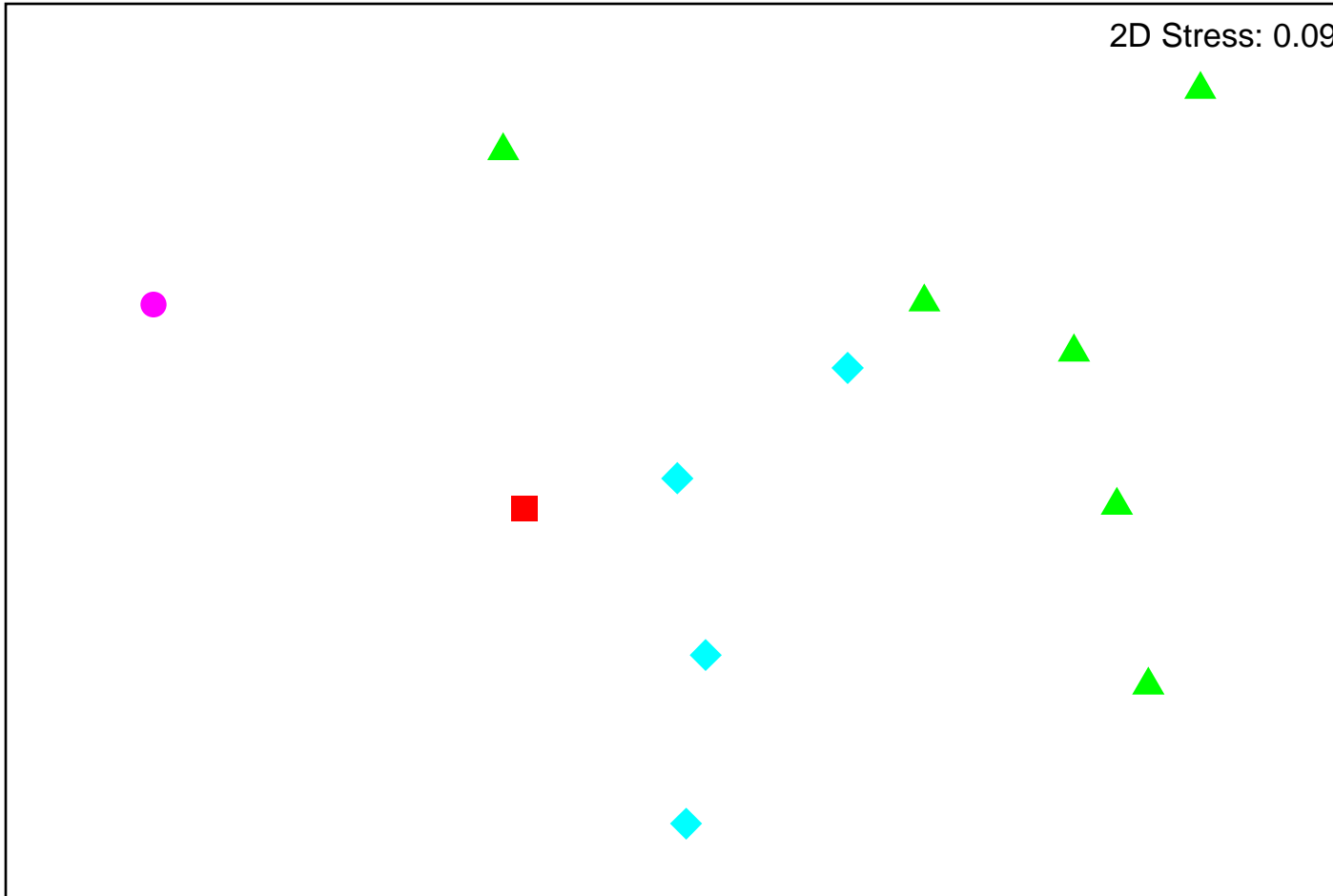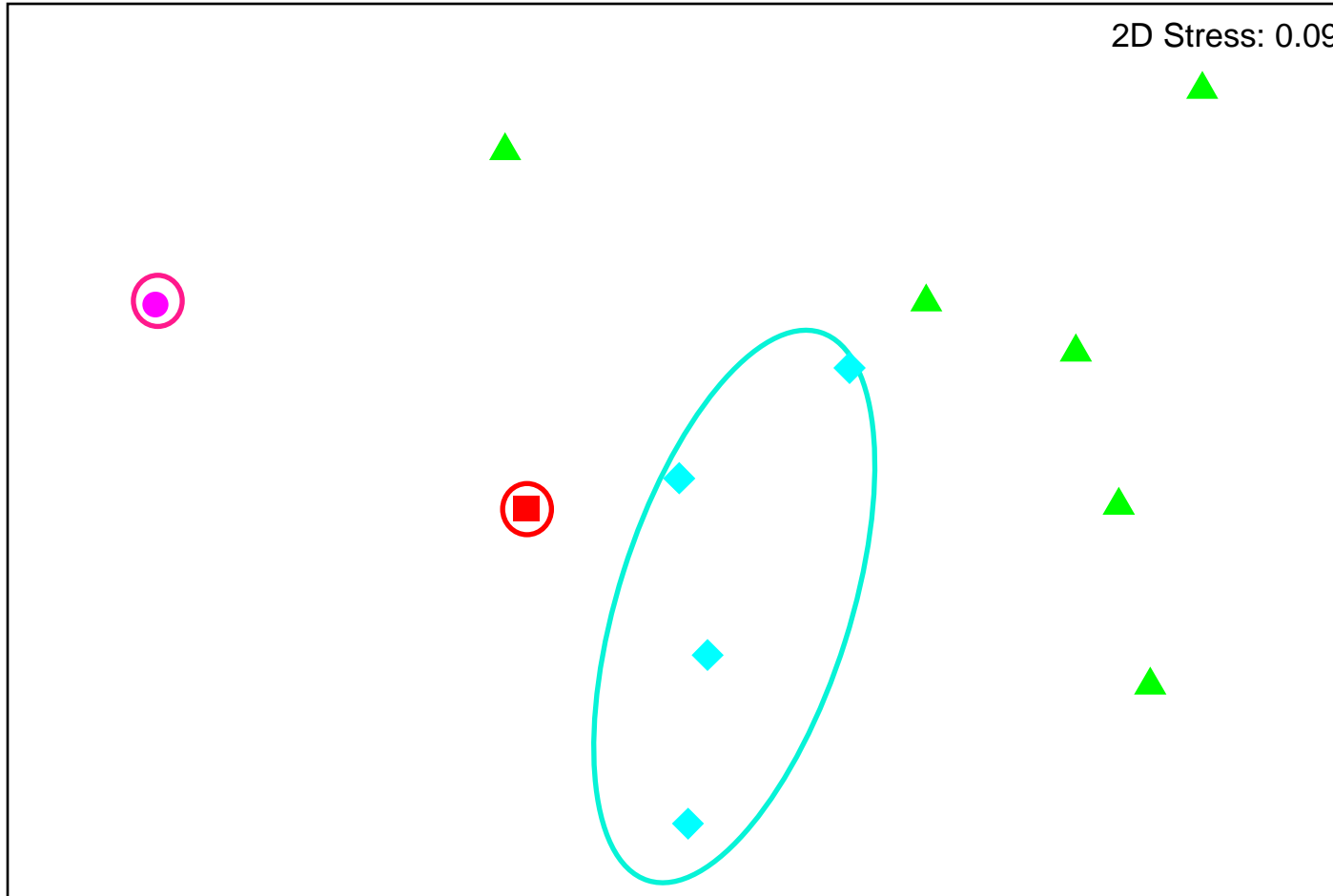
Corixa spp.

Results

Small Pools Biota- 2015
Transform: Presence/absence
Resemblance: S17 Bray Curtis similarity (+d)

2D Stress: 0.09

Month SiteType
- ▲ June Reference
- ■ July Impacted
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Tiny Fish
Tom Cod
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