Halvautomatisk analyse av hjertemorfologi som et nytt verktøy for vurdering av hjertehelse hos laksefisk

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Forsker

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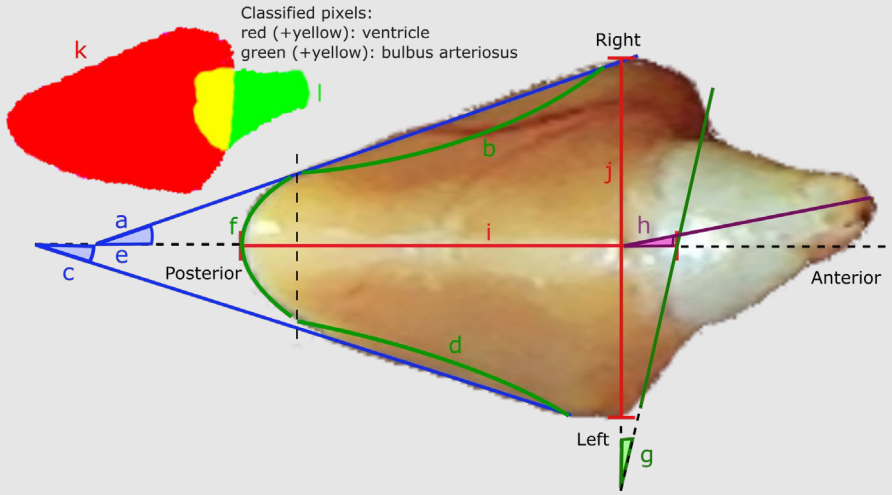
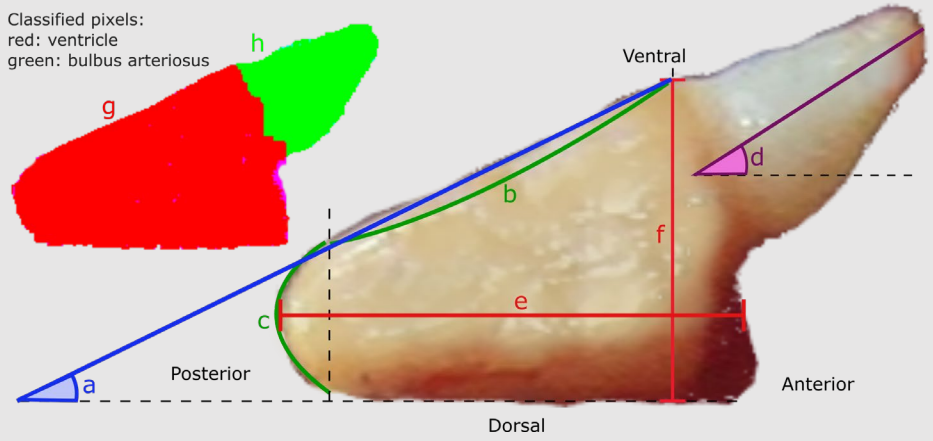
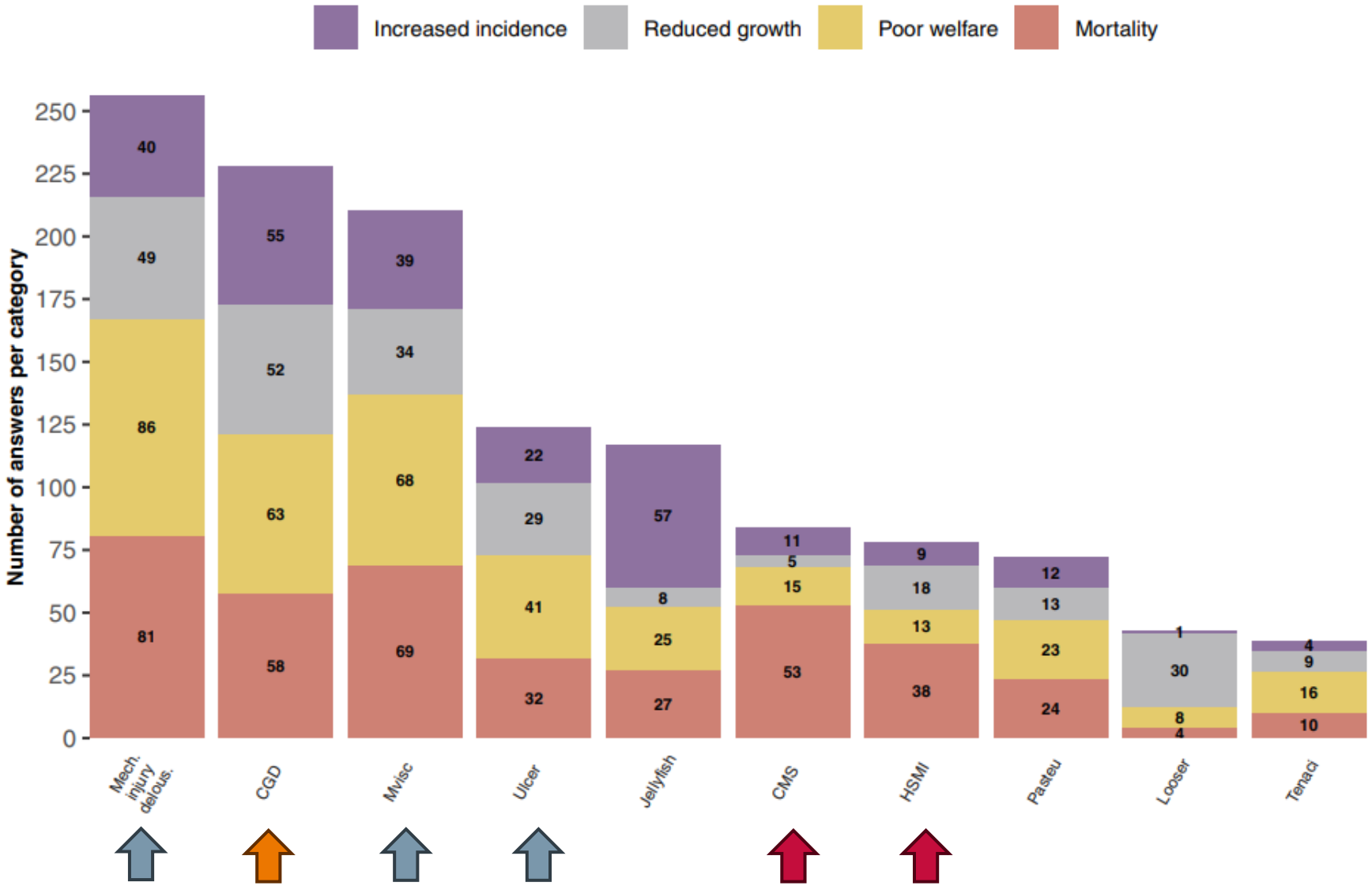
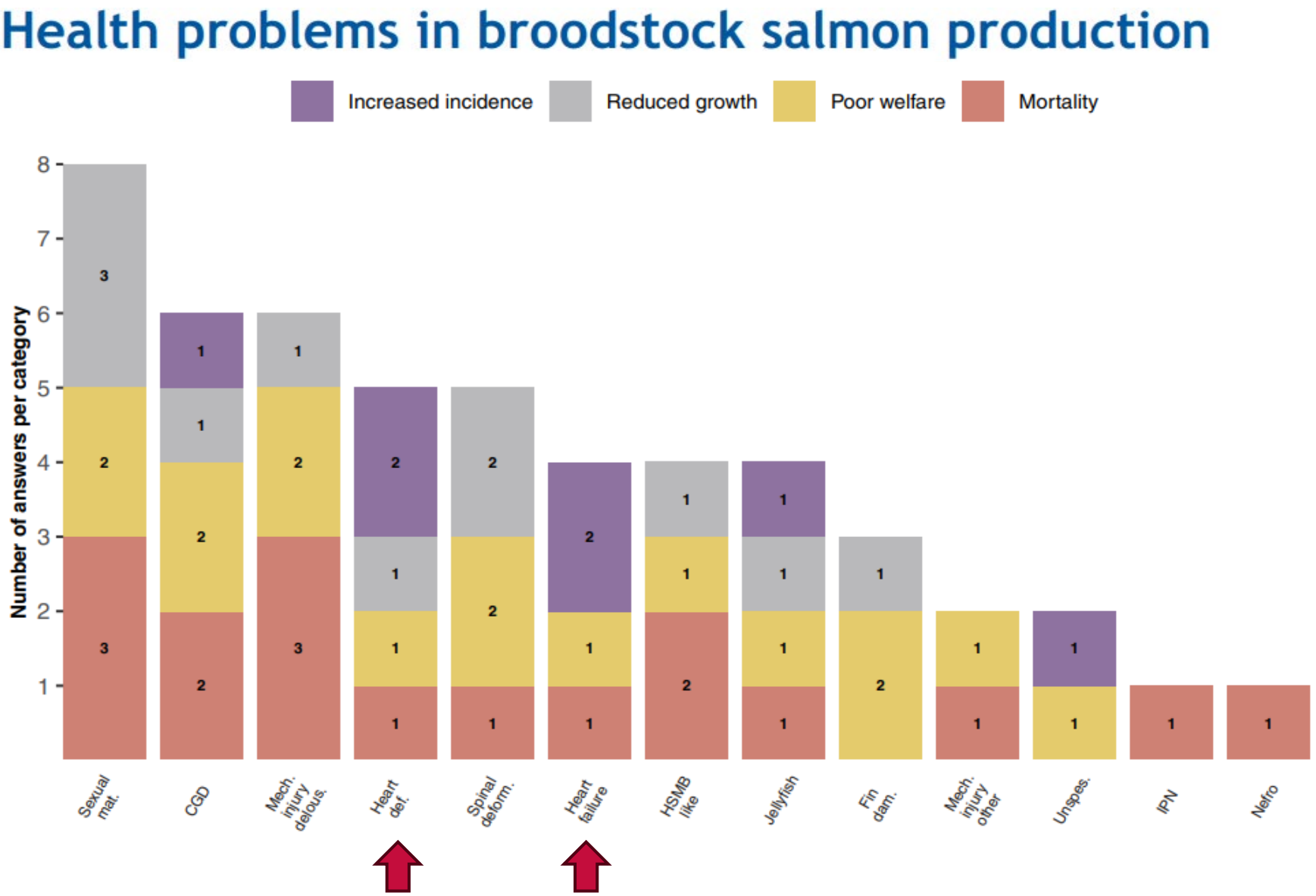




Why heart health matters



Why heart health matters



How to investigate heart health

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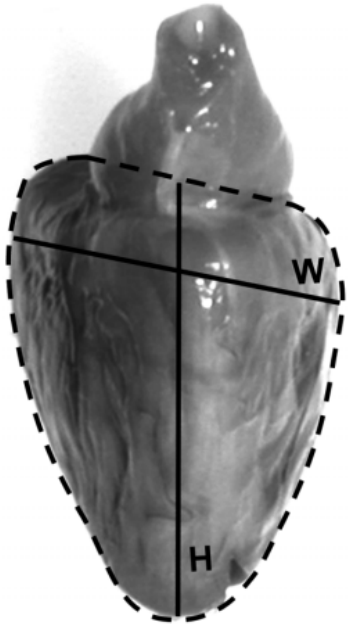
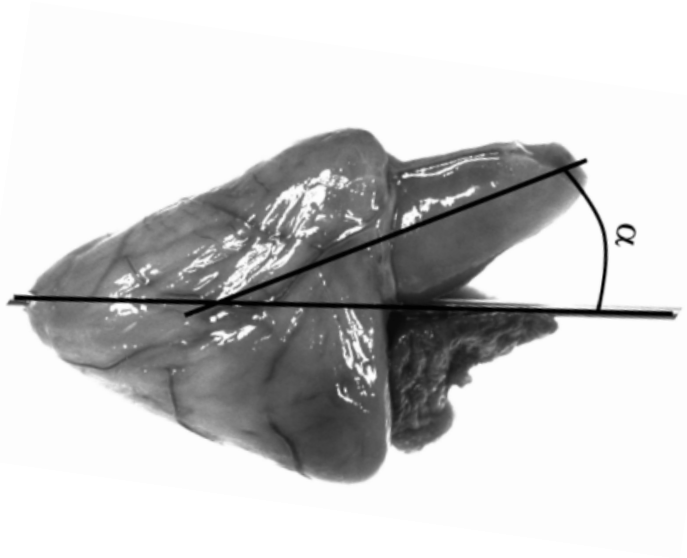
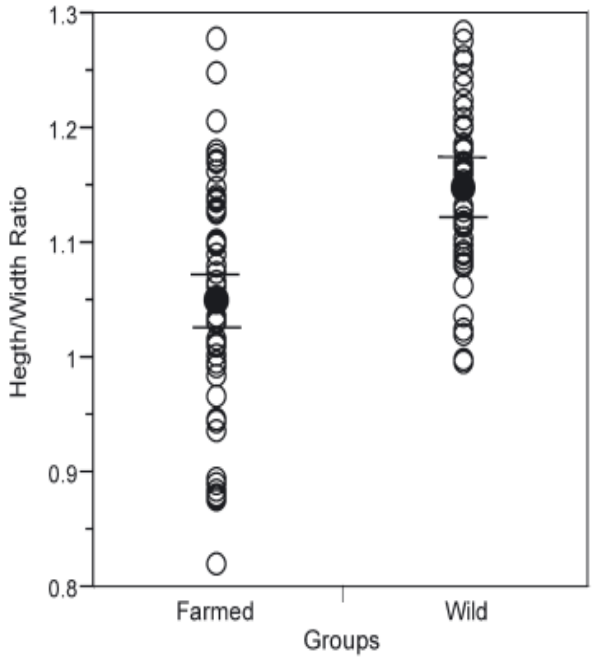
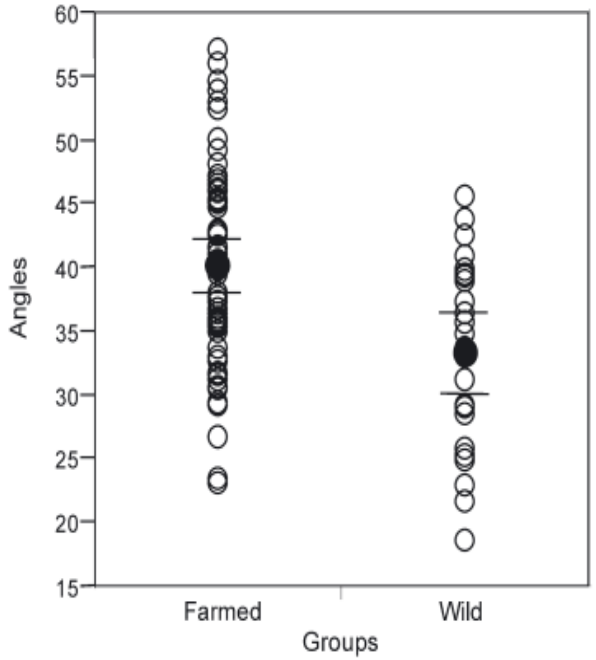
Heart morphology in wild and farmed Atlantic salmon *Salmo salar* and rainbow trout *Oncorhynchus mykiss*

Trygve T. Poppe[1,*], Renate Johansen[2], Gjermund Gunnes[1], Brit Tørud[3]



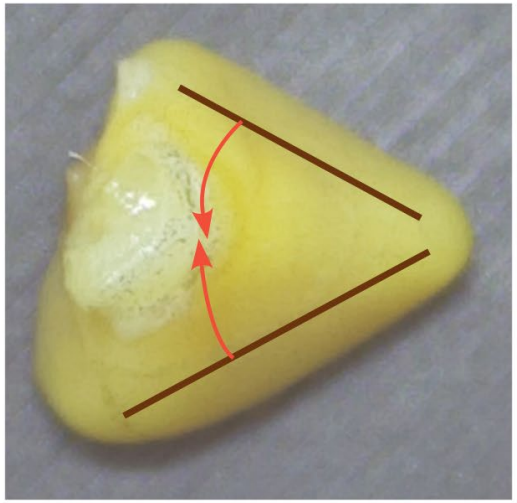


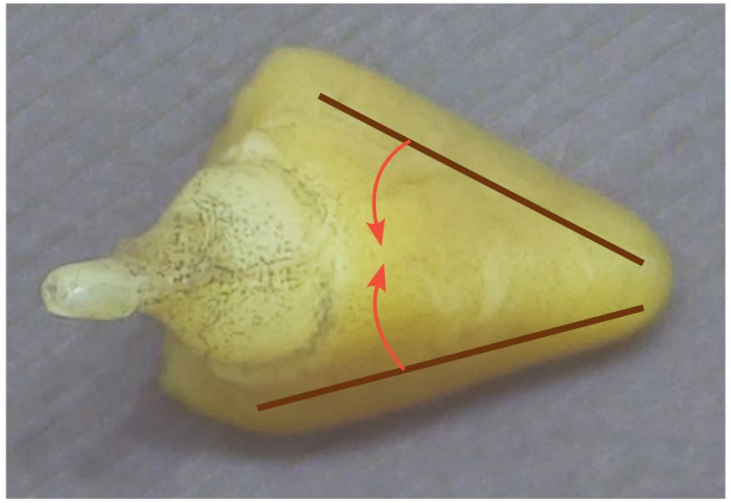


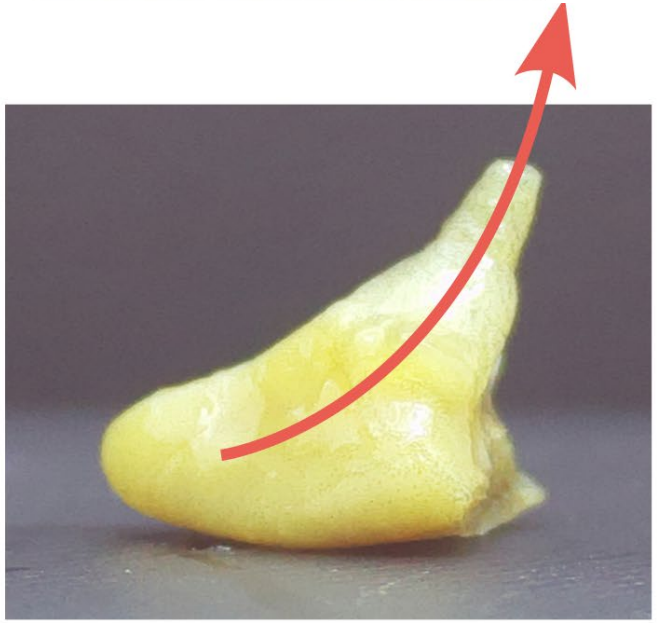


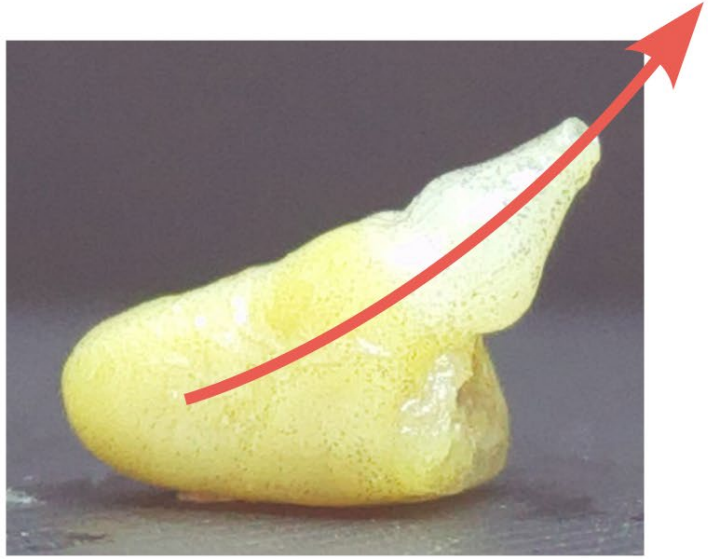
- Hearts from farmed fish (both salmon and trout) are relatively wider and the bulbus angle is steeper

Why morphology matters





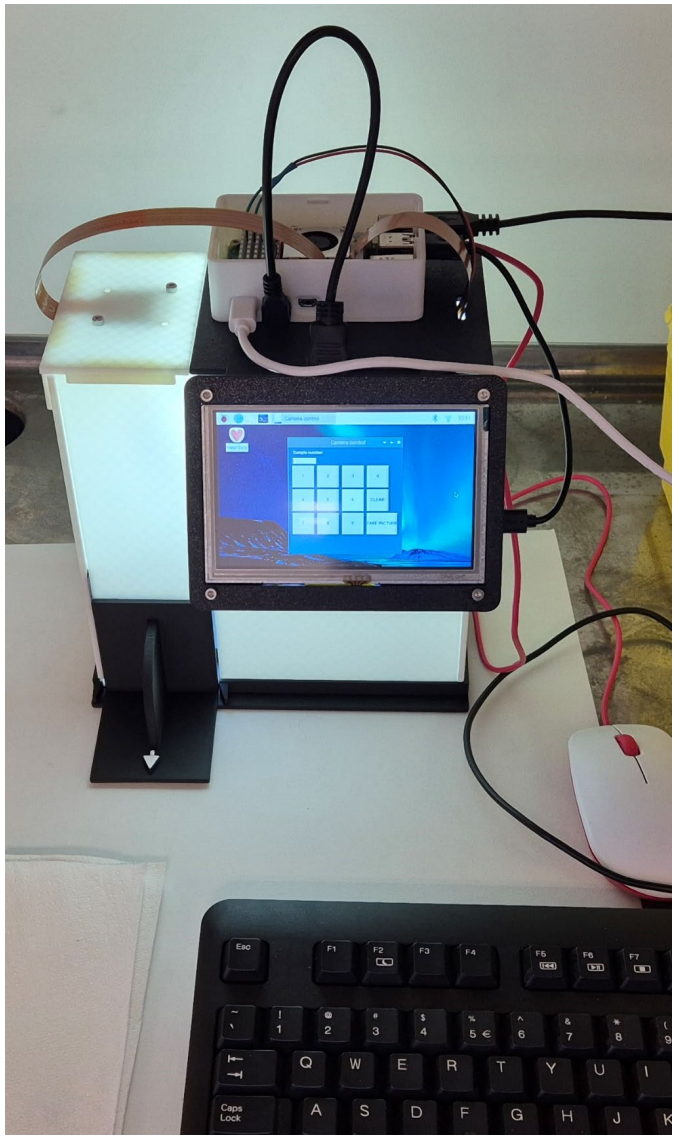




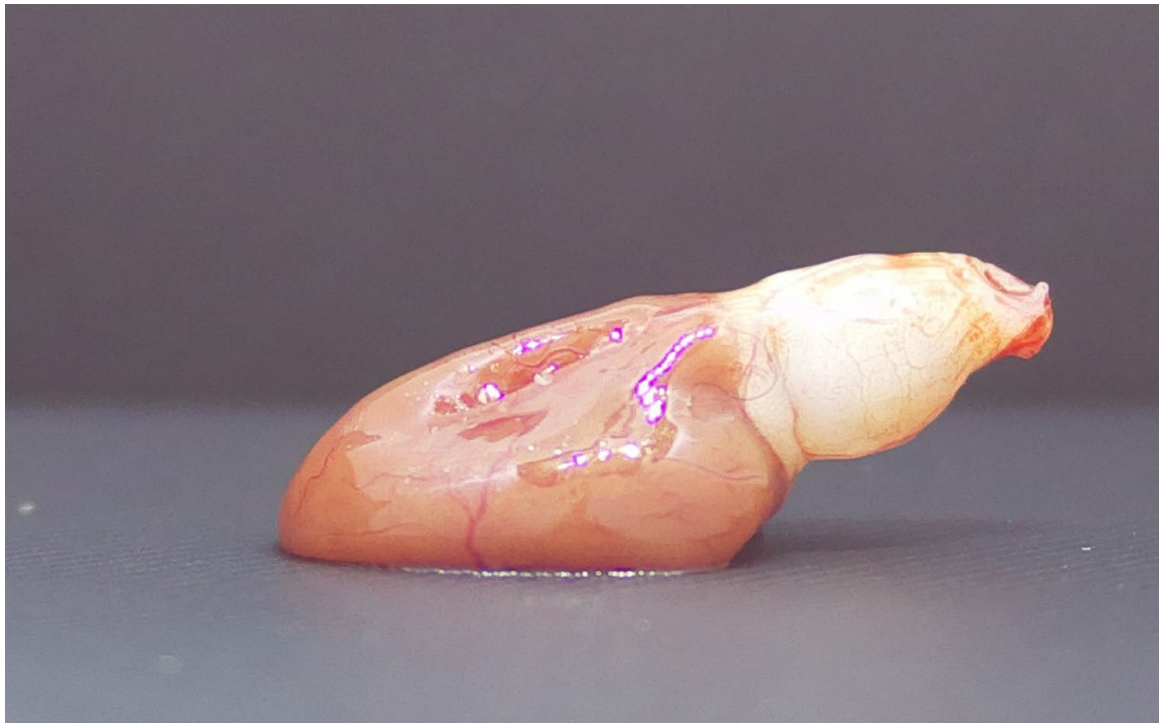
How to investigate heart morphology

- Problems:
  - Manual measurements are labor-intensive
  - Difficult to standardize
  - Limited number of variables

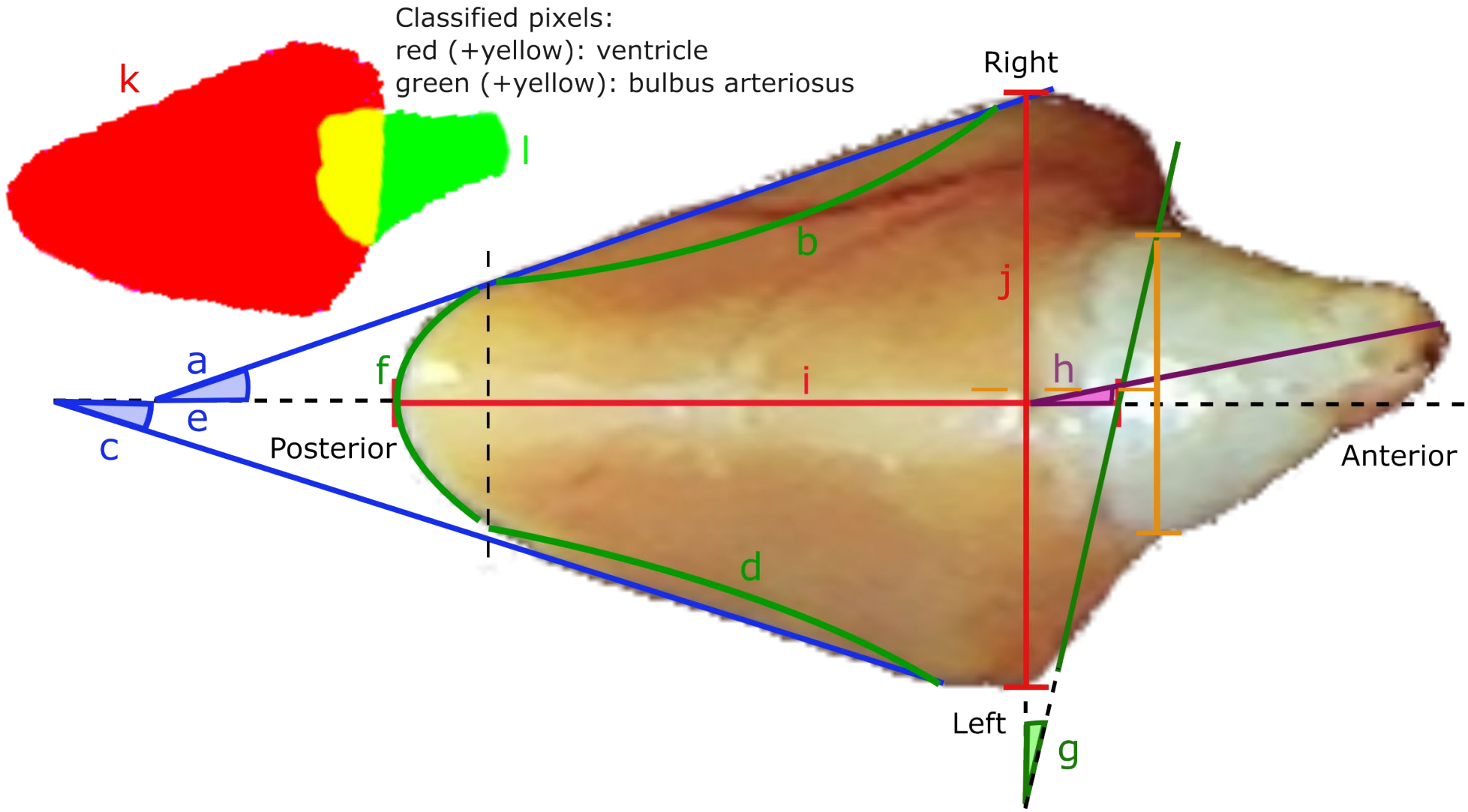
- Idea: Take standardized images (top and side) of the hearts and let the computer do the work
- In addition:
  - Heart tissue may be used in additional analyses
  - Transportable stand-alone equipment
  - Replace weighing of the heart (CSI)
  - Hearts can be fresh, on PBS or on formalin



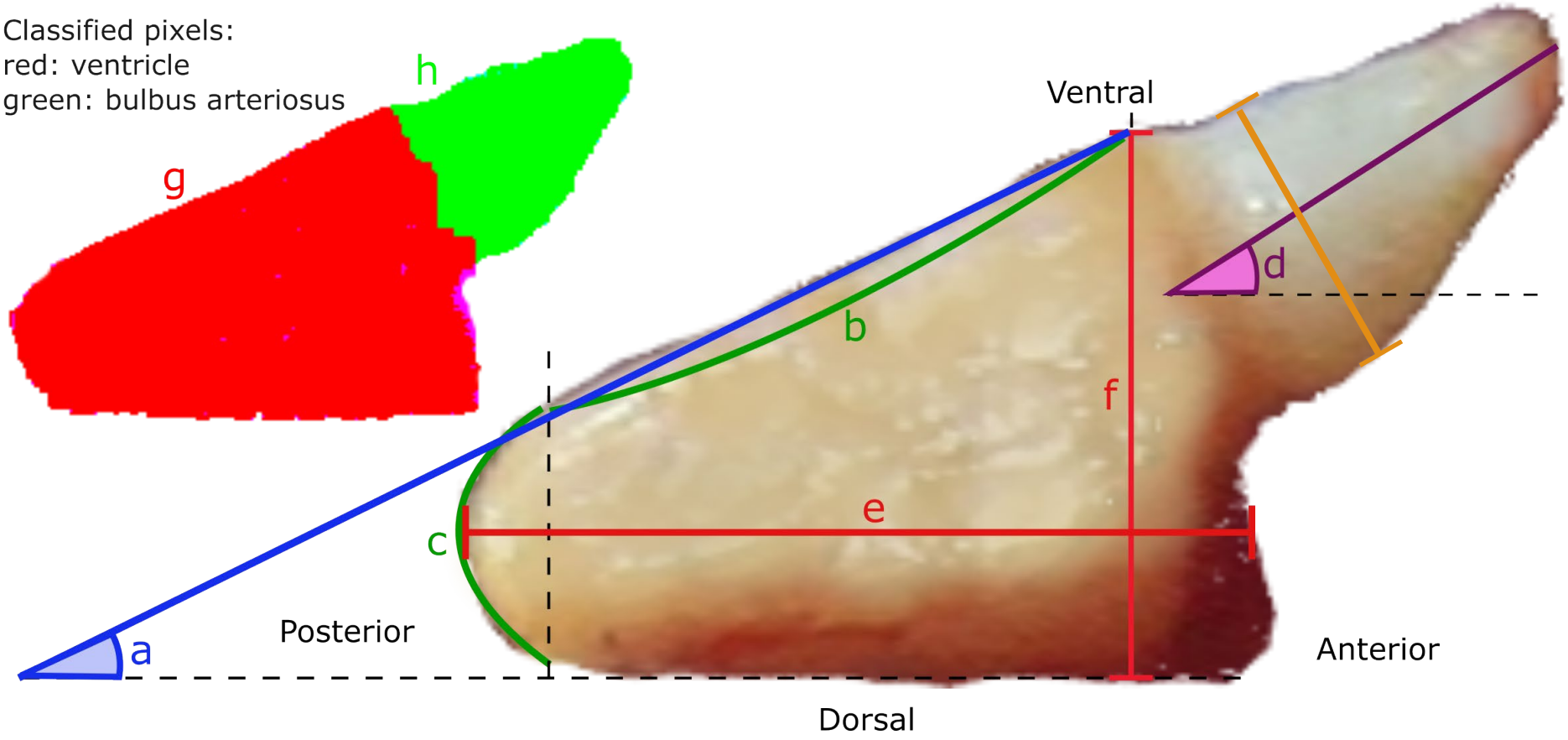
How to investigate heart morphology



Variables


Classified pixels:
red (+yellow): ventricle
green (+yellow): bulbus arteriosus
k
l
Right
b
j
a
f
i
h
e
c
Posterior
Anterior
d
Left
g

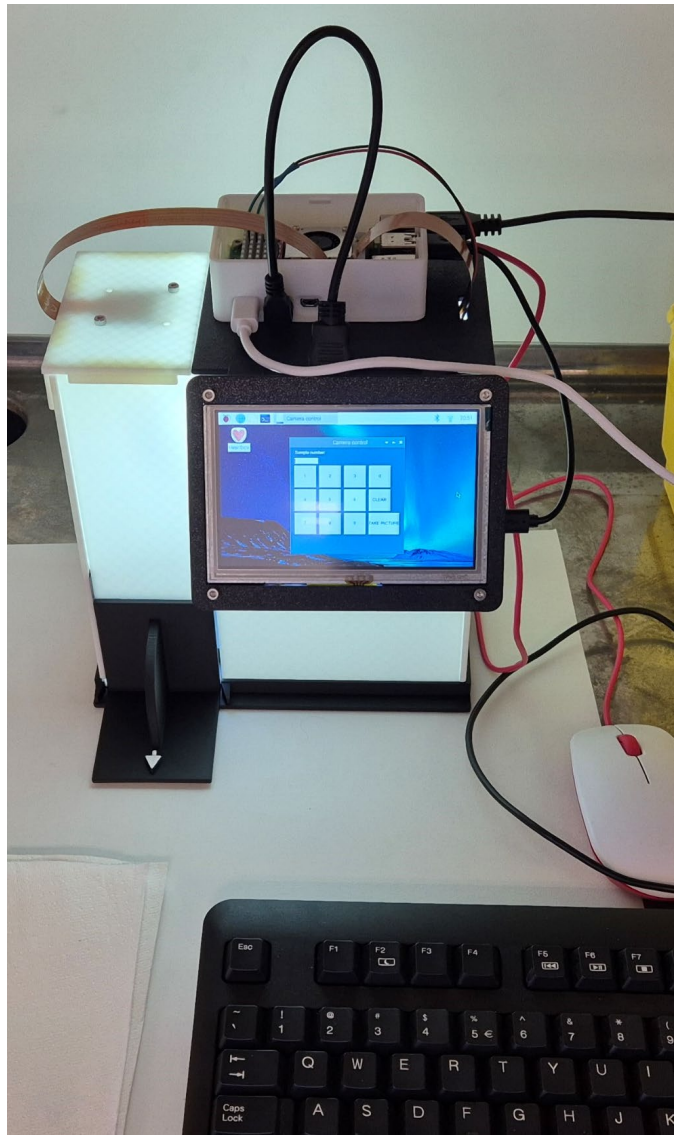
Variables


Classified pixels:
red: ventricle
green: bulbus arteriosus
h
g
Ventral
d
b
f
e
c
Posterior
a
Anterior
Dorsal

Heart morphology data

- The method was used in several project and more than 5000 hearts were analyzed

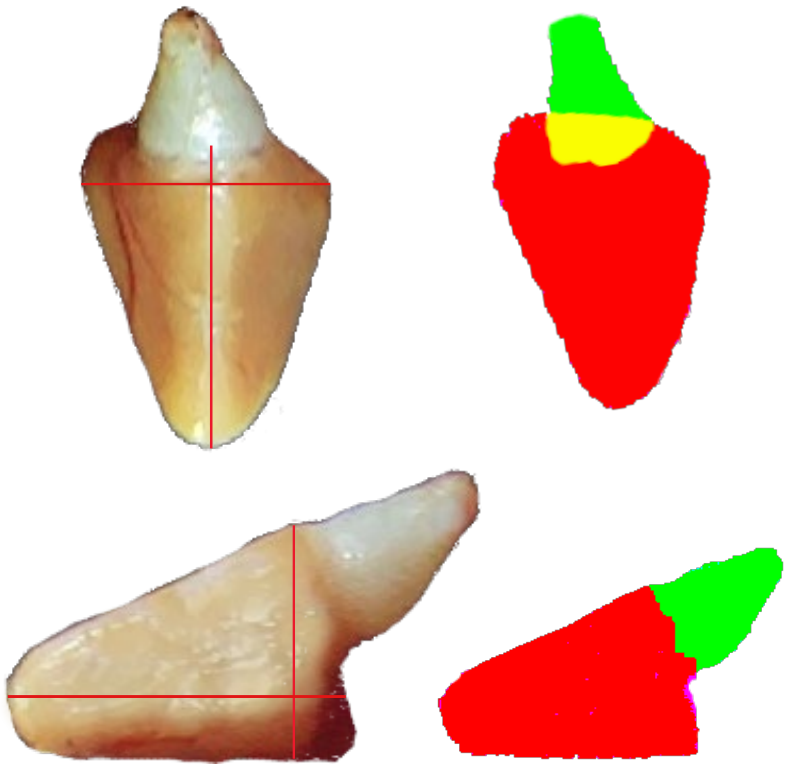
- Focus on:
  - Differences due to storage medium
  - Morphological changes by factor:
    - Rearing temperature
    - Training
    - Cross-species comparison (salmon and trout)
    - Genetic background

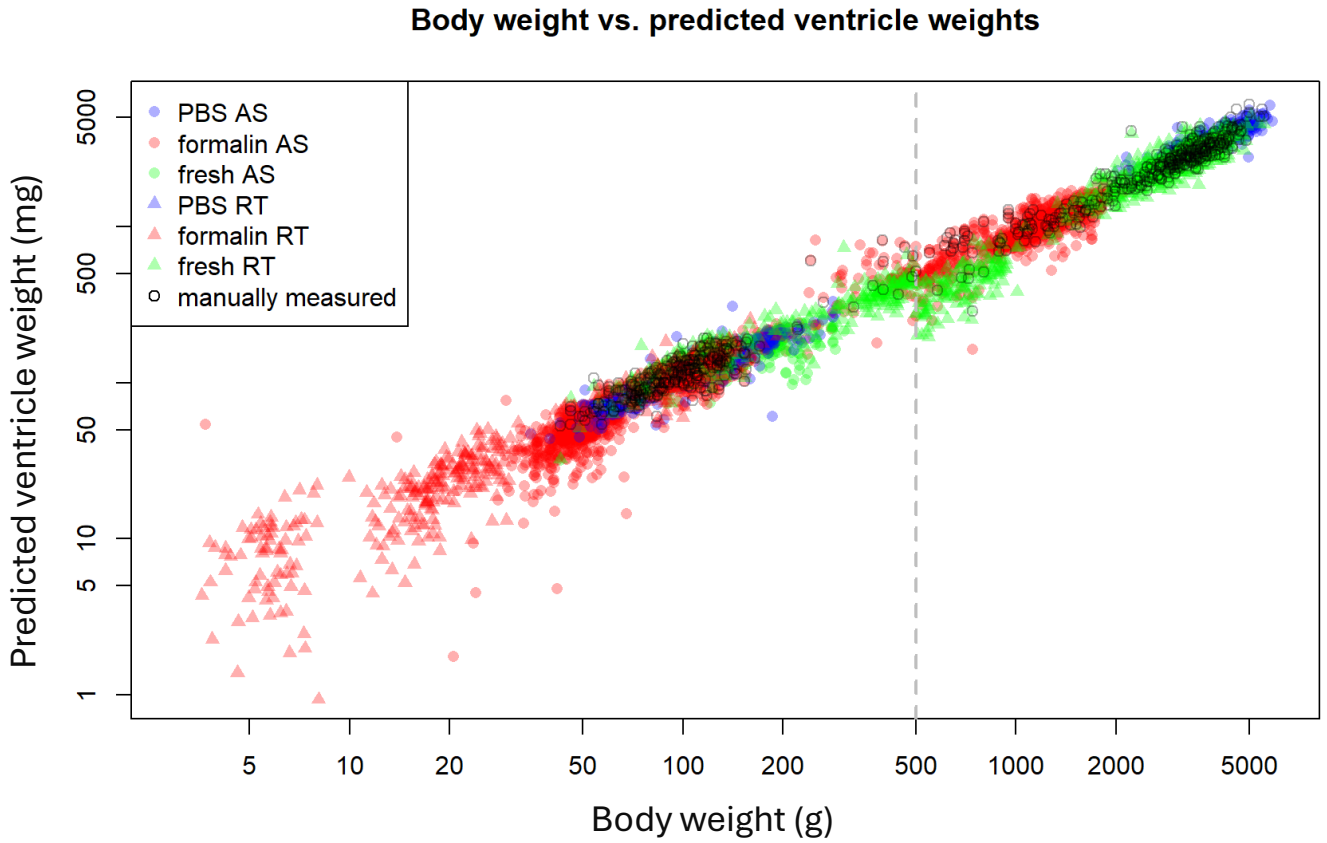


Prediction of ventricle weight

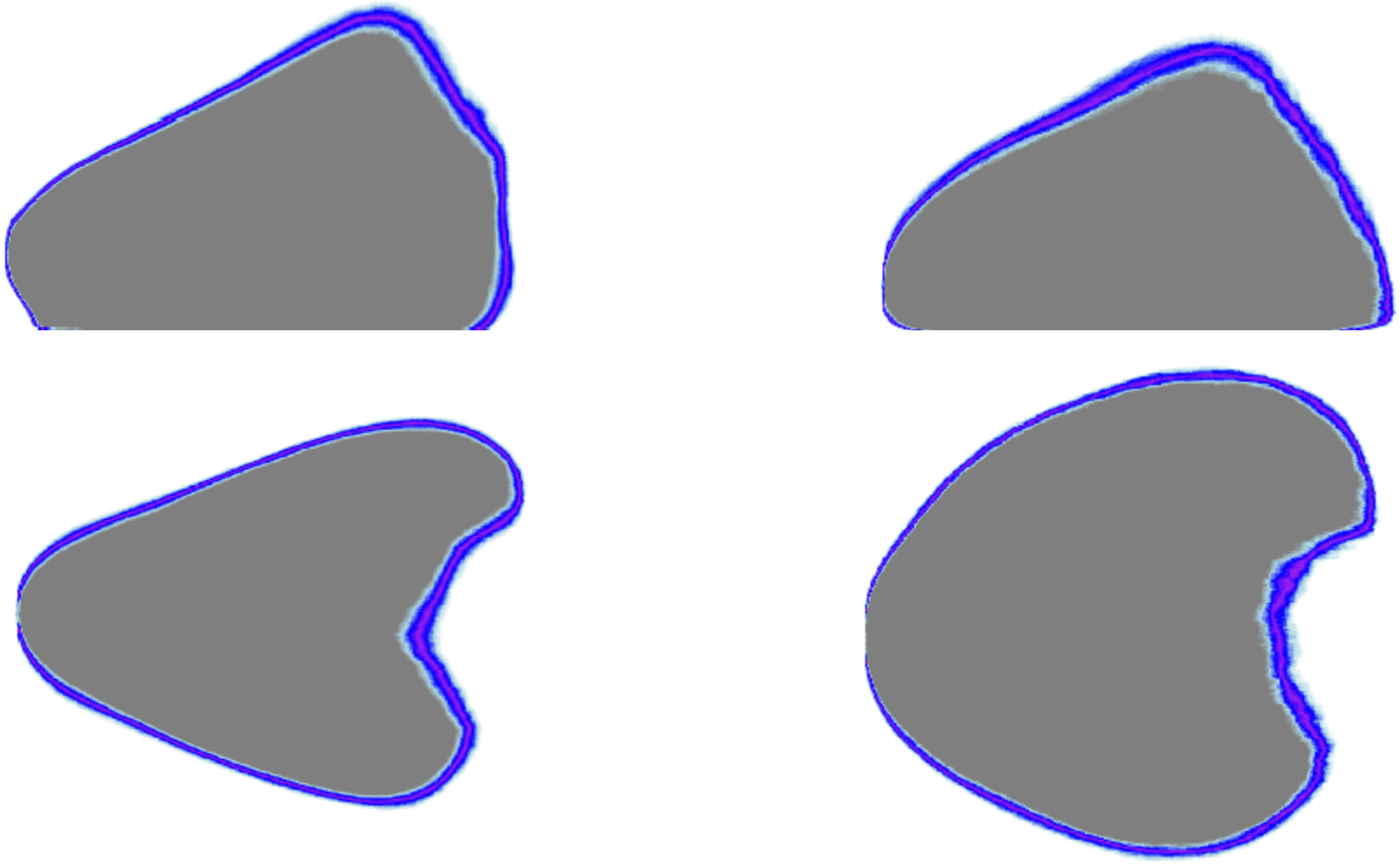
- Replacement of weighing, no removal of the bulbus

```
Ventricle.weight ~ top.ventricle.mm2 + top.length.mm + top.width.mm + top.bulbus.mm2 +
                   side.ventricle.mm2 + side.length.mm + side.height.mm + side.bulbus.mm2
```



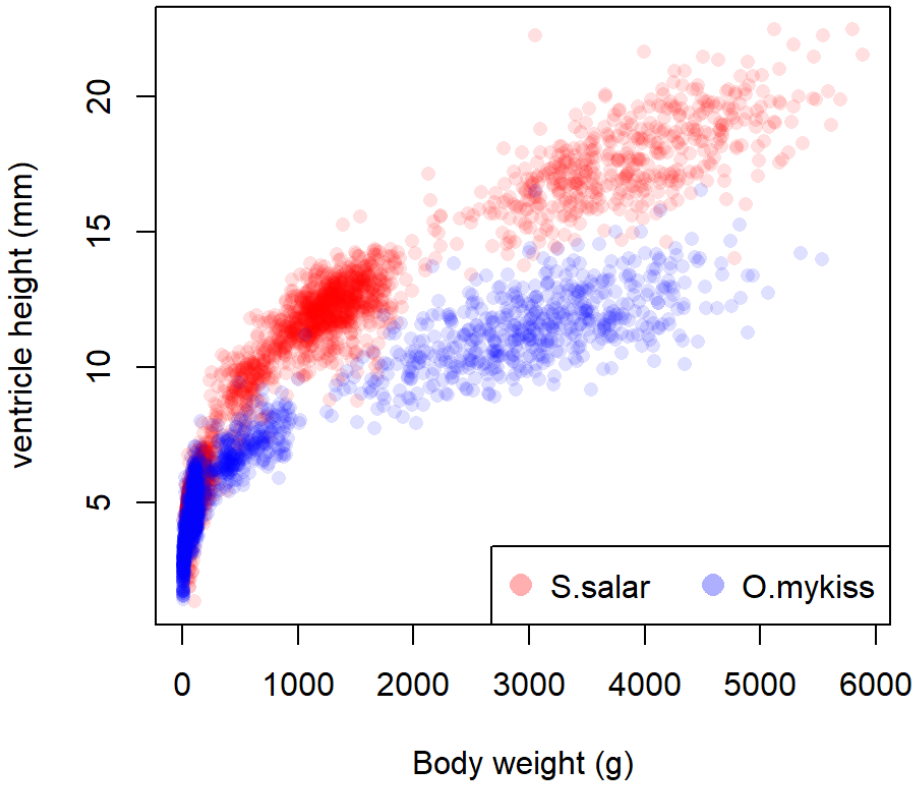


Salmon vs trout hearts

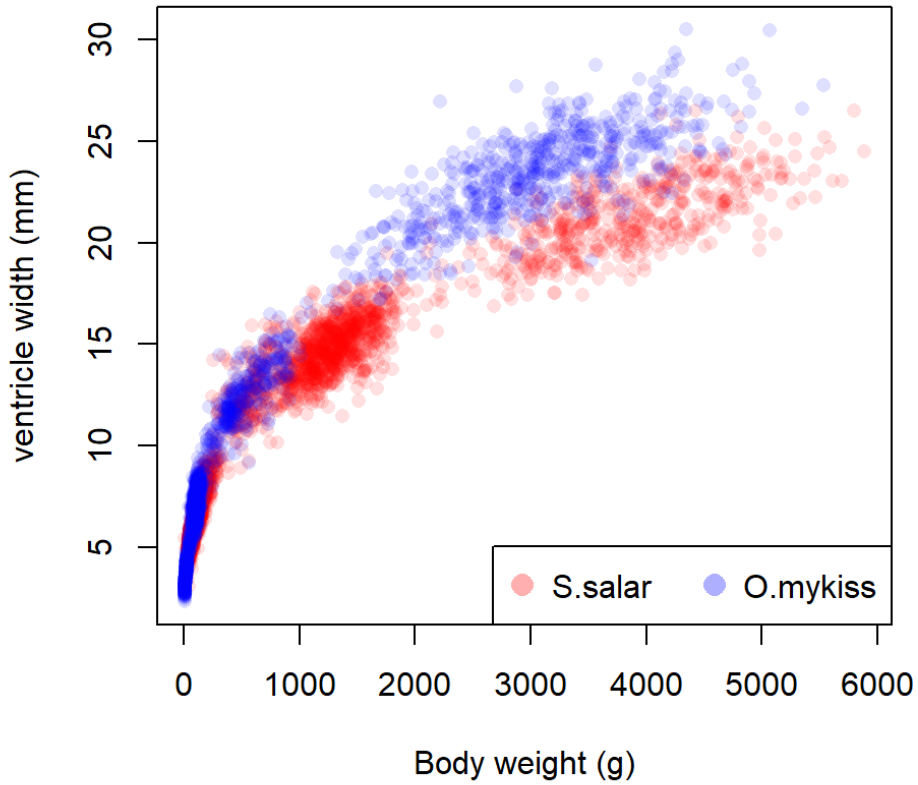


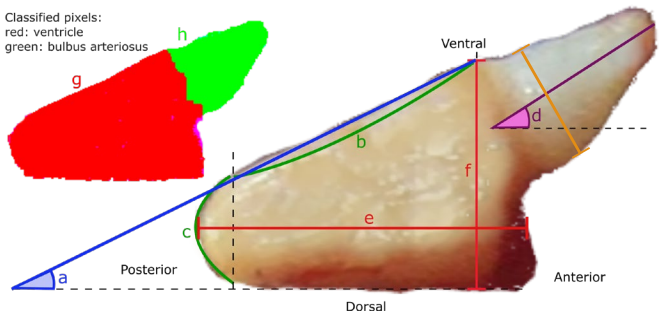
- Average heart shapes of ~400 fish each

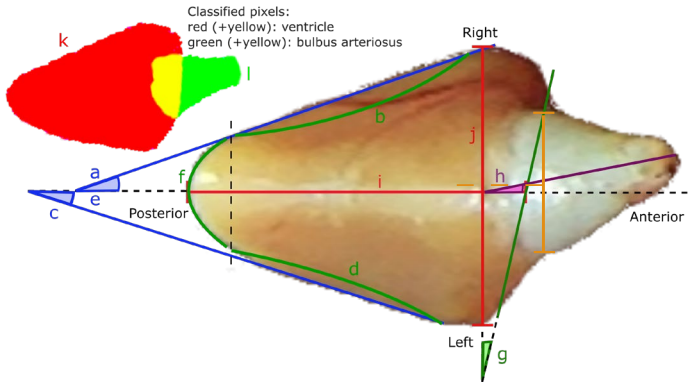
Body weight vs. ventricle height

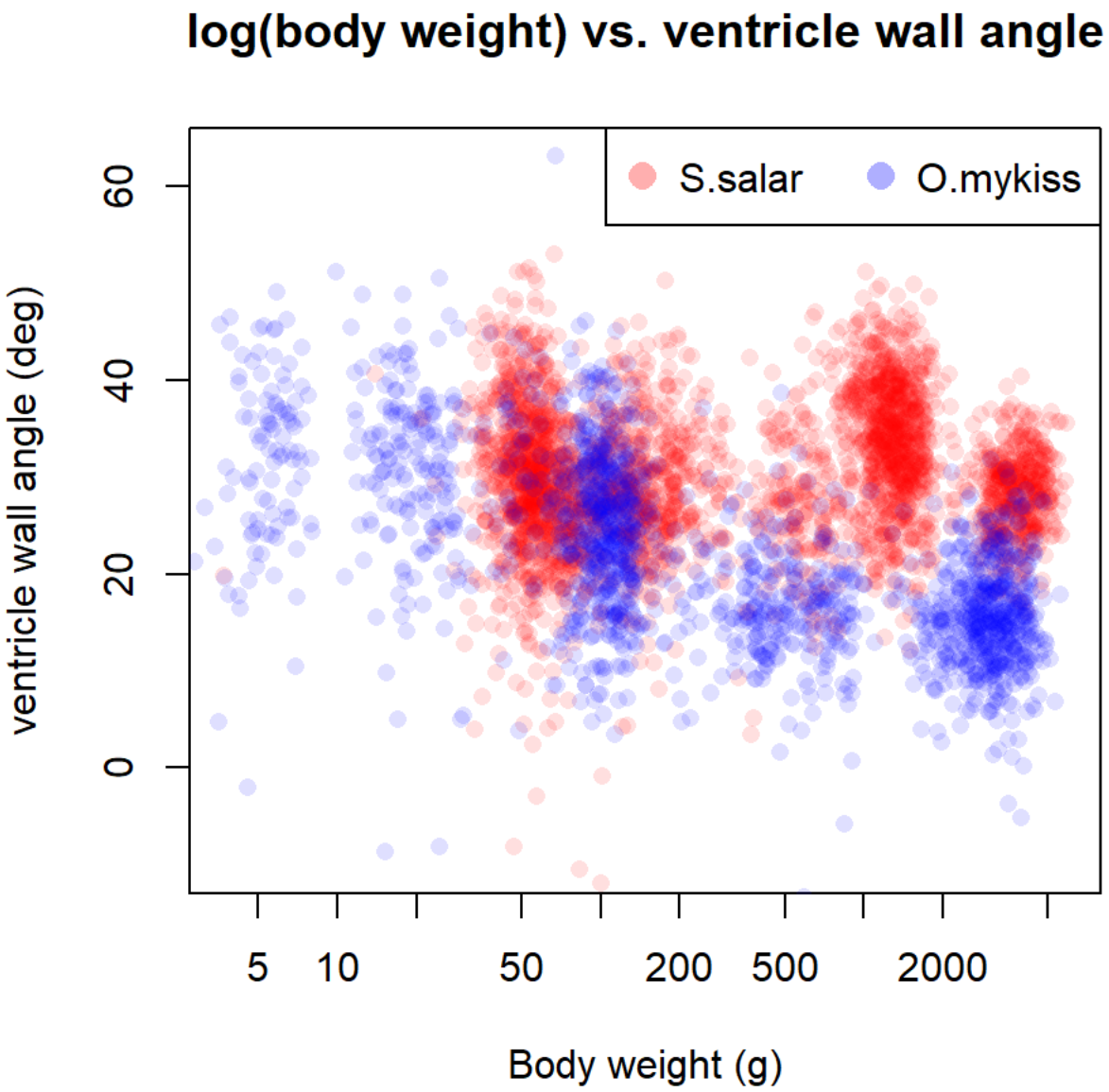


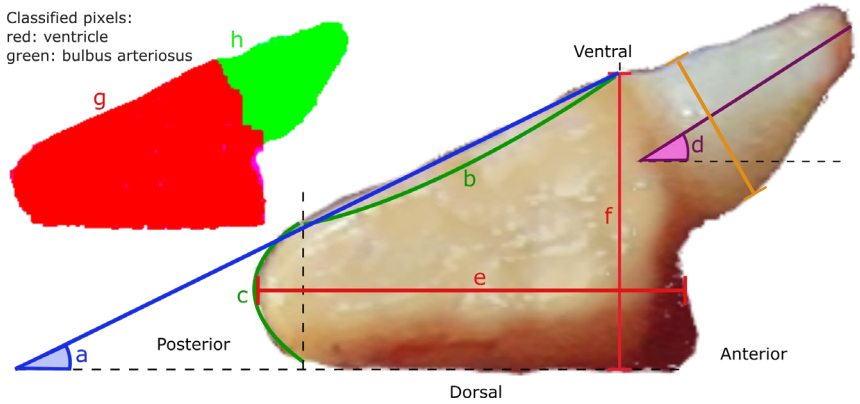
Body weight vs. ventricle width

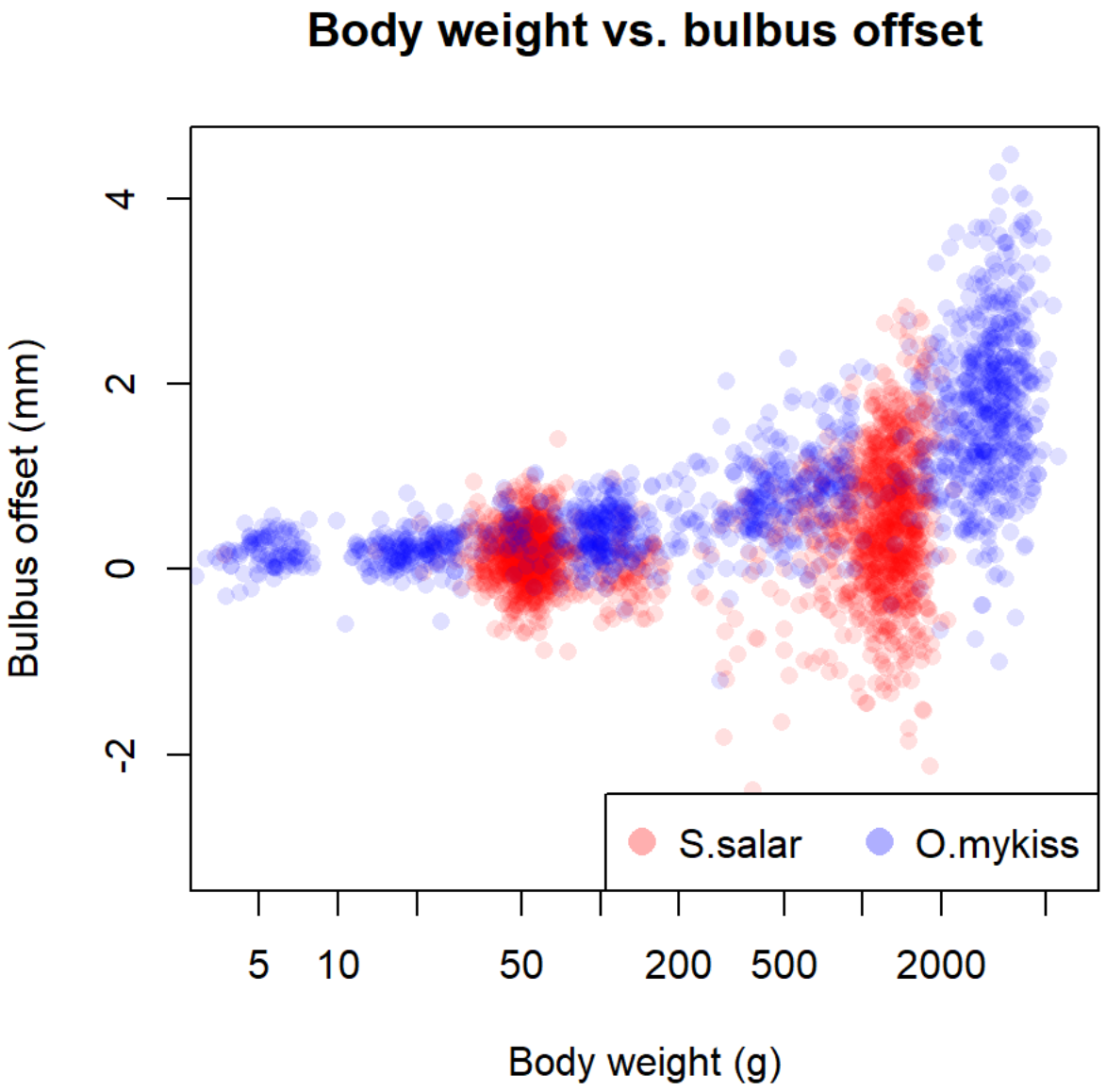


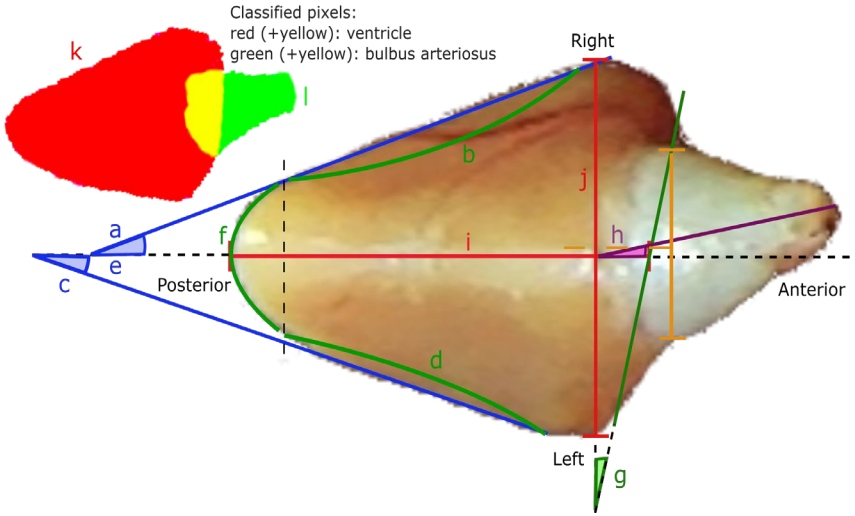





log(body weight) vs. ventricle wall angle
S.salar
O.mykiss
ventricle wall angle (deg)
0
20
40
60
5
10
50
200
500
2000
Body weight (g)


Classified pixels:
red: ventricle
green: bulbus arteriosus
h
g
Ventral
d
b
f
e
c
a
Posterior
Anterior
Dorsal


Body weight vs. bulbus offset
Bulbus offset (mm)
4
2
0
-2
5
10
50
200
500
2000
Body weight (g)
S.salar
O.mykiss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k
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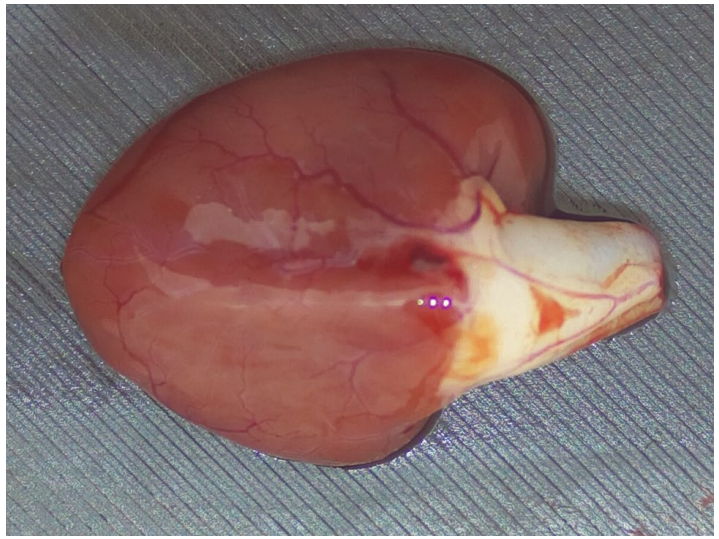
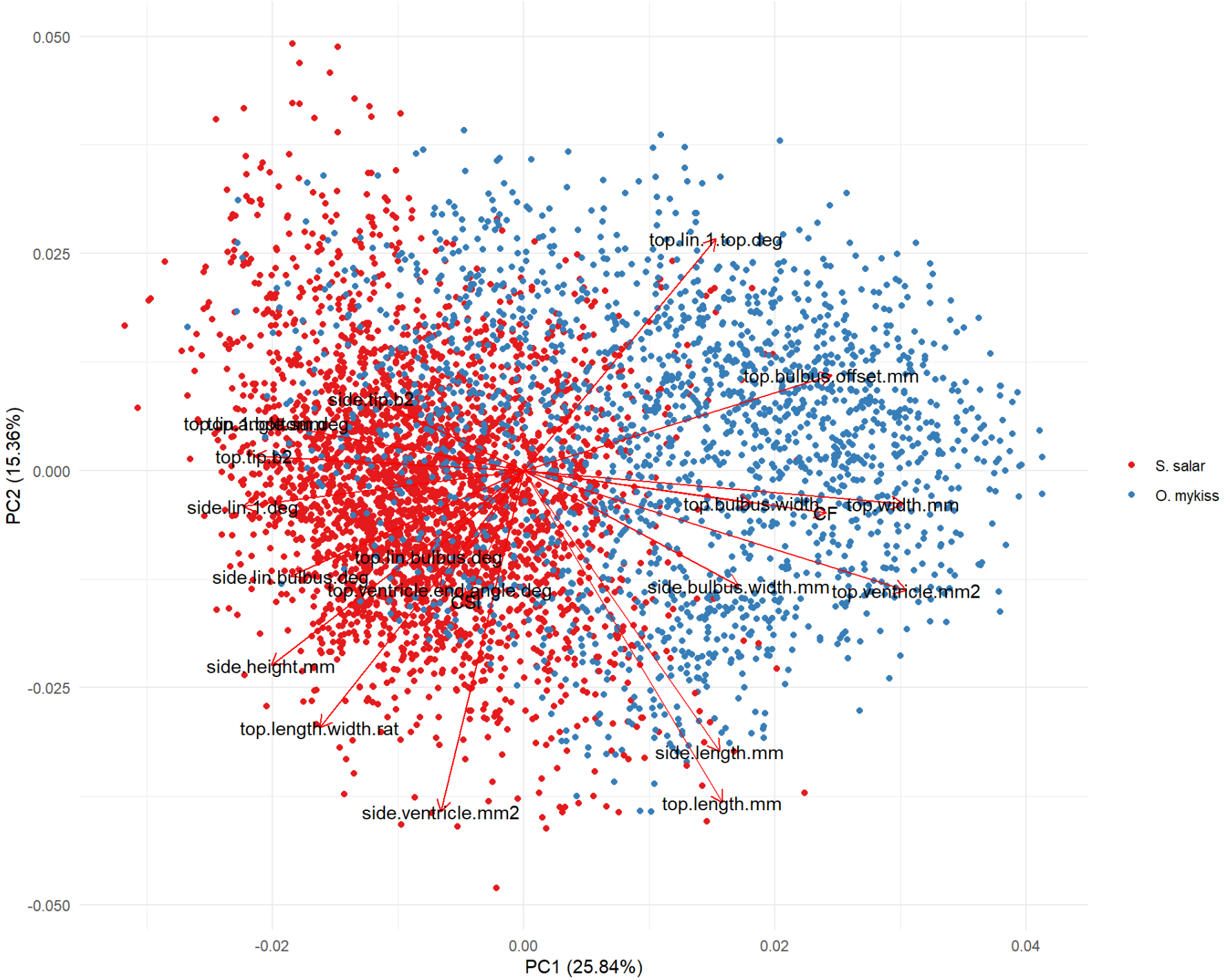
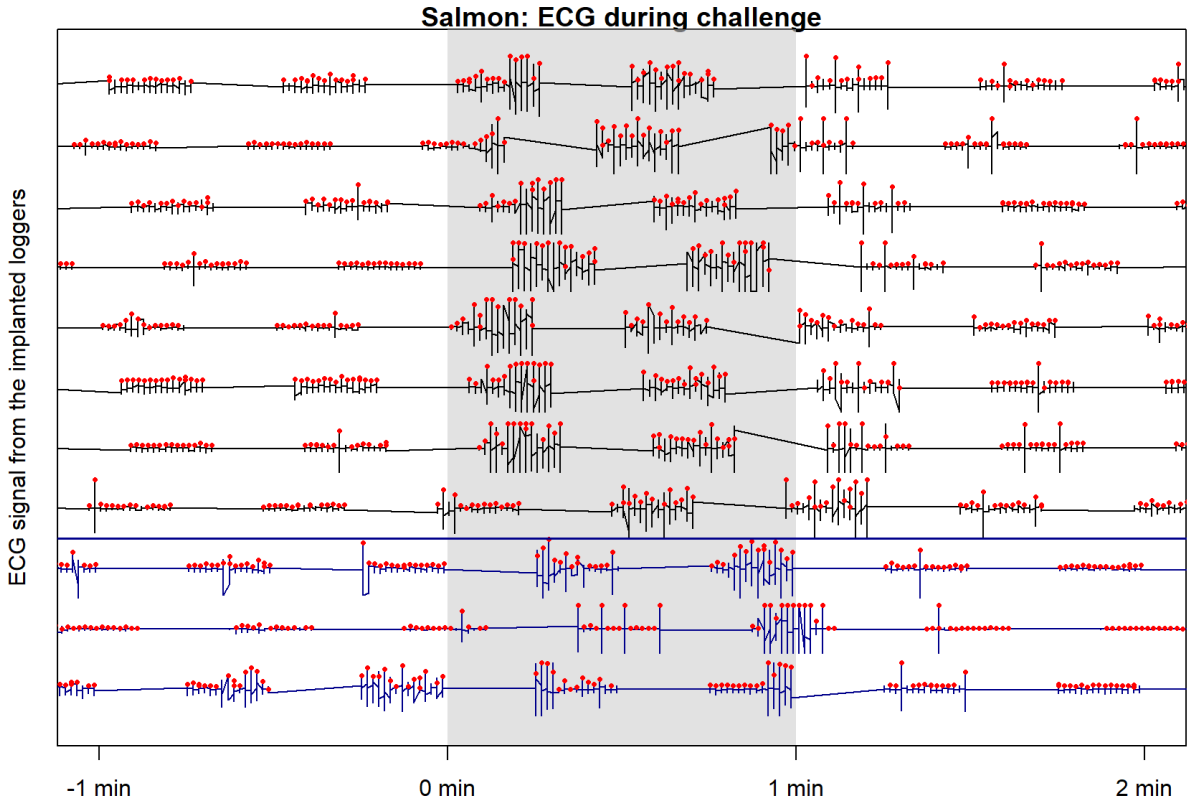
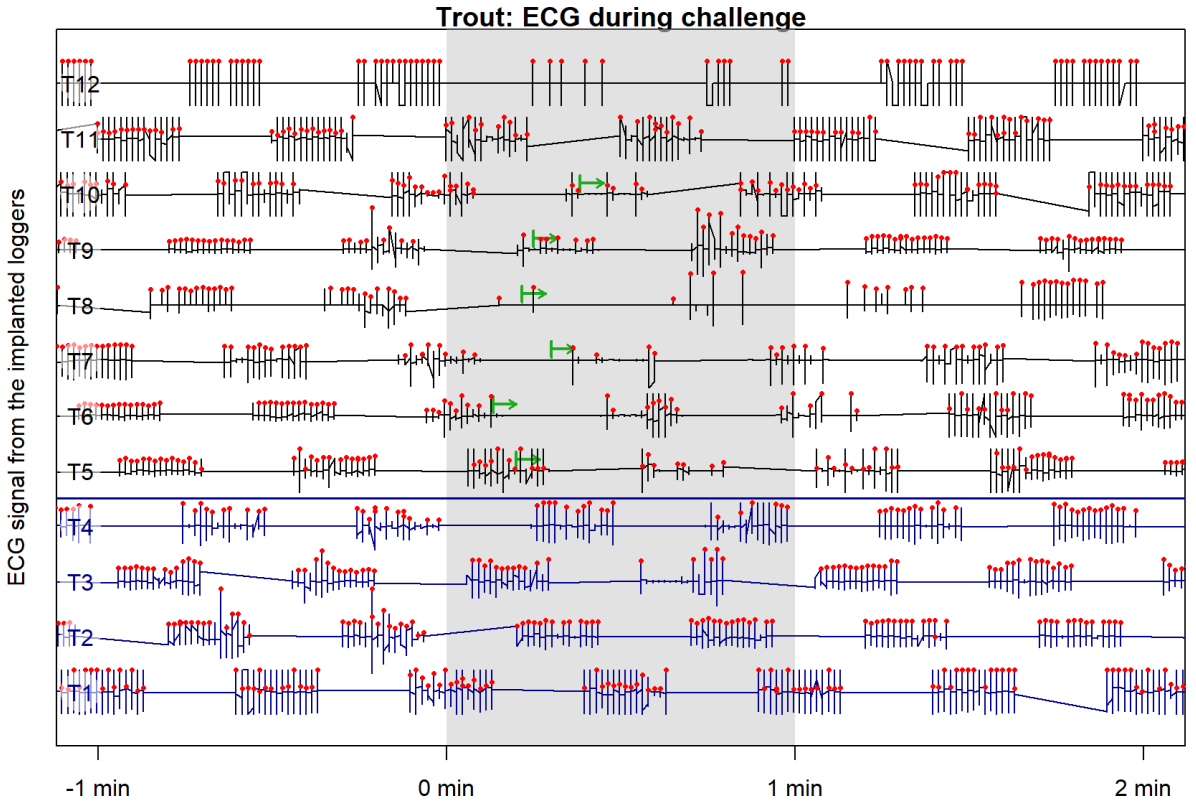
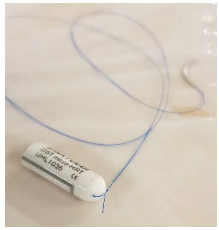



0.050
0.025
0.000
-0.025
-0.050
PC2 (15.36%)
-0.02
0.00
0.02
0.04
PC1 (25.84%)
top.lin.1.top.deg
top.bulbus.offset.mm
side.tip.b2
top.tip.b2
side.lin.1.deg
top.bulbus.width
CF
top.width.mm
top.lin.bulbus.deg
side.lin.bulbus.deg
top.ventricle.end.angle.deg
CSI
side.bulbus.width.mm
top.ventricle.mm2
side.height.mm
top.length.width.rat
side.length.mm
top.length.mm
side.ventricle.mm2
S. salar
O. mykiss

ECG data (implanted) during 32°C heat exposure







Conclusion

- Heart morphology can now be analyzed without minimal effort
- Novel method that is suited for high sample numbers
  - Can be used in addition to other methods
  - Can replace weighing of the heart
  - The growing database has the potential to
    - Increase our understanding of heart morphology
    - Monitor heart health development
    - Provide risk factor assessment
    - Contribute to better heart health of farmed salmonids