Freshwater invertebrate composition depends on river salinity

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Background

- Tidal rivers are a part of an estuary, and its flow and level are influenced by the tides (Spencer et al. 2016).
- Salinization is a threat to the structure and ecological functioning of tidal rivers
  - Rising sea levels will displace wetlands and alter the tidal range in rivers.
  - Droughts reduce freshwater input into tidal rivers, which raises salinity in estuaries, and enables salt water to mix further upstream (USEPA 2021; Spencer, et al. 2016).
- Freshwater macro-invertebrates can be used to assess the physical and chemical health of streams.
  - They are sensitive to pollution and changes in their habitat and support complex food webs as primary consumers and decomposers (Timpano, et al. 2018).

Goal

Quantify the composition of freshwater invertebrates in three tidal streams to see how assemblages change across a salinity gradient.

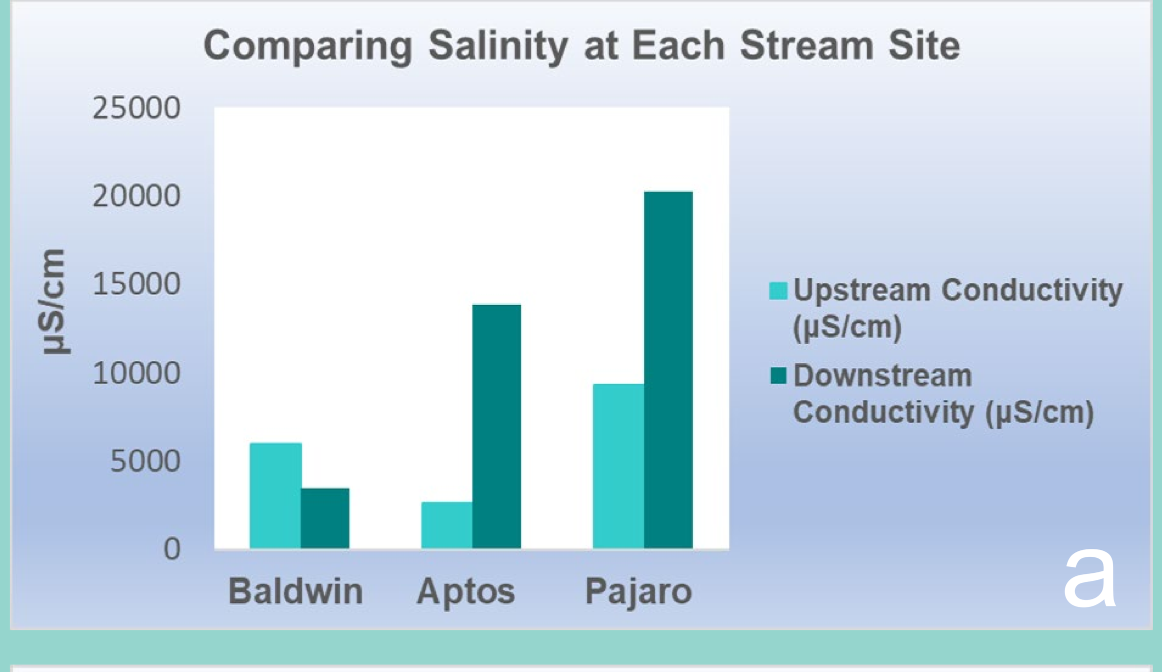
Methods

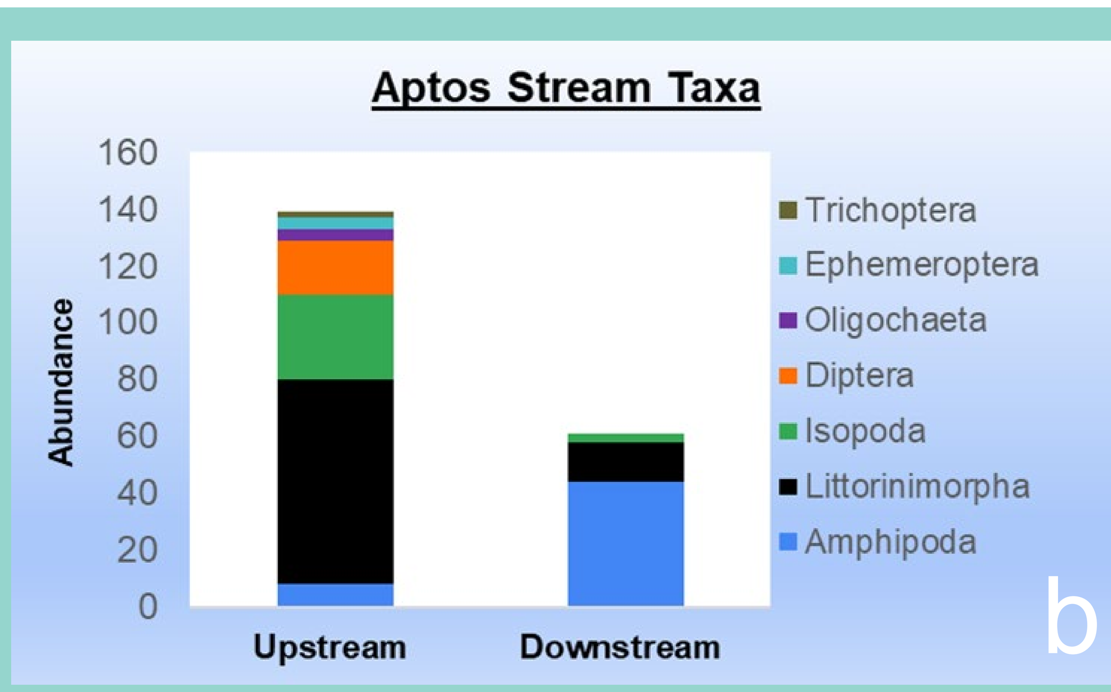
We collected macro-invertebrates using leaf packs made up of cottonwood leaves (Figure 2a). Leaf packs were placed in a upstream and downstream section of three tidal streams (Pajaro, Aptos, Baldwin) for one month (Figure 2c). In addition to leaf packs, loggers were placed into the streams to record conductivity and temperature of the stream every fifteen minutes. At the end of the month leaf packs and loggers were removed from the streams and the macro-invertebrates were picked out and placed into vials with 70% Ethanol (Figure 2a). Then, the macro-invertebrates were identified to order and counted to quantify the composition of bugs in each of the three tidal streams (Figure 2b).

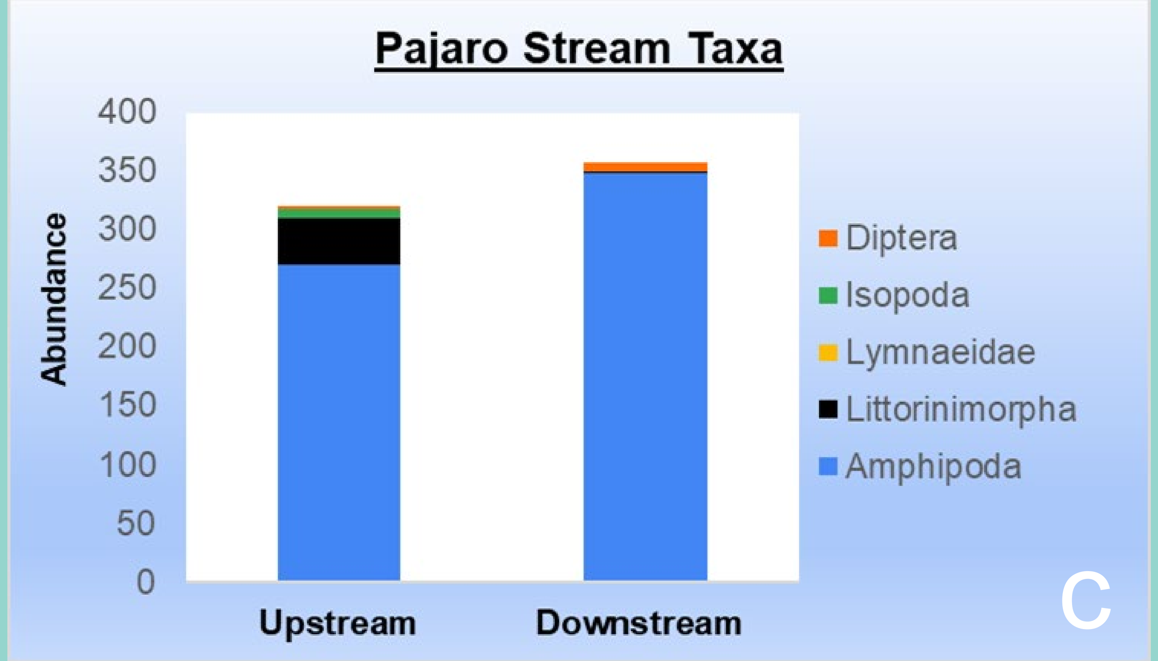
Figure 1: Example of a leaf pack and logger zip tied to rebar (a), Identifying freshwater macro-invertebrates using a microscope (b), Overview map showing the sampled locations of Pajaro (green), Aptos (purple), and Baldwin streams (orange) (c).

Results

- Higher level of taxa diversity at Baldwin and Aptos sites compared to Pajaro site (Figure 2b,c,d).
- For all three sites there was greater taxa diversity upstream compared to downstream (Figure 2).
- Baldwin, unlike the other two sites, had a higher conductivity reading at its upstream location compared to its downstream location (Figure 2a).







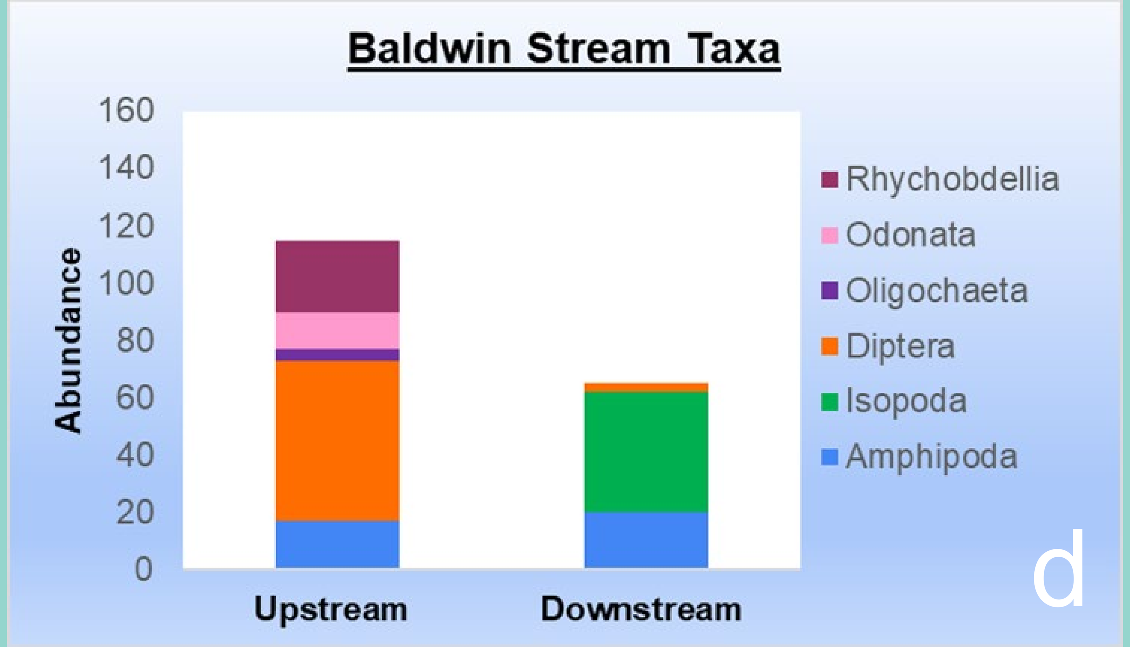


Figure 2: Graph comparing upstream and downstream conductivity at each stream (a), Graph comparing the upstream and downstream taxa abundance at Aptos Stream (b), Graph comparing the upstream and downstream taxa abundance at Pajaro Stream (c), Graph comparing the upstream and downstream taxa abundance at Baldwin stream (d).

Conclusion

- Pajaro stream site had higher conductivity readings compared to the other two sites and this might be because it is located near agriculture fields. Agricultural runoff of fertilizers like nitrates and phosphates could increase salinity nutrients in the river.
- There are two potential reasons that we saw a greater taxa diversity upstream compared to downstream.
  - The macro-invertebrates cannot tolerate increased salinity levels (Timpano, et al 2018; Wolf, et al 2010). Apart from Baldwin, we saw that the upstream sites had lower conductivity readings compared to downstream sites.
  - Macroinvertebrates drift to escape unfavorable conditions and colonize new habitats. The invertebrates are drifting from further upstream but stopping before salinity increases to an intolerable level and they pile up on one another creating a higher levels of diversity at our upstream sites (Svendsen, et al 2004).

This research is important because aquatic invertebrate metacommunities will likely indicate diminishing biological health with increasing tidal influence.

Future Work

- First time New Zealand mud snails were detected at the Pajaro. This will feed into future research to determine if leaf packs are a practical method to identify the presence of mud snails.
- In fall, we are planning on deploying leaf packs in four new stream channels and retrieving one leaf pack per week at each of the four sites.

Figure 3: Picture showing a New Zealand mud snail on fingertip.

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Acknowledgements

This research was funded by the Undergraduate Research Opportunities Center (UROC) .

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