

Lobster larvae in the Bay of Fundy: consideration of risk due to turbine developments in Minas Passage

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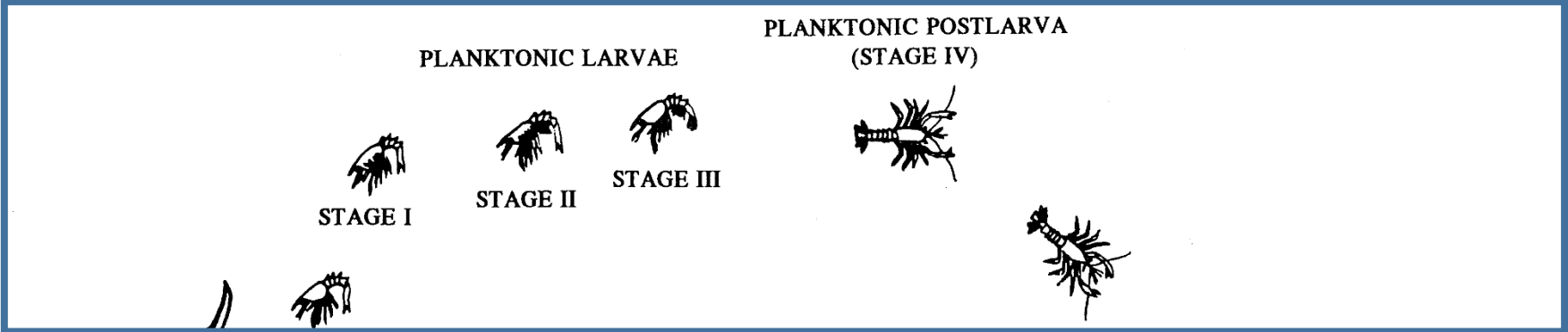
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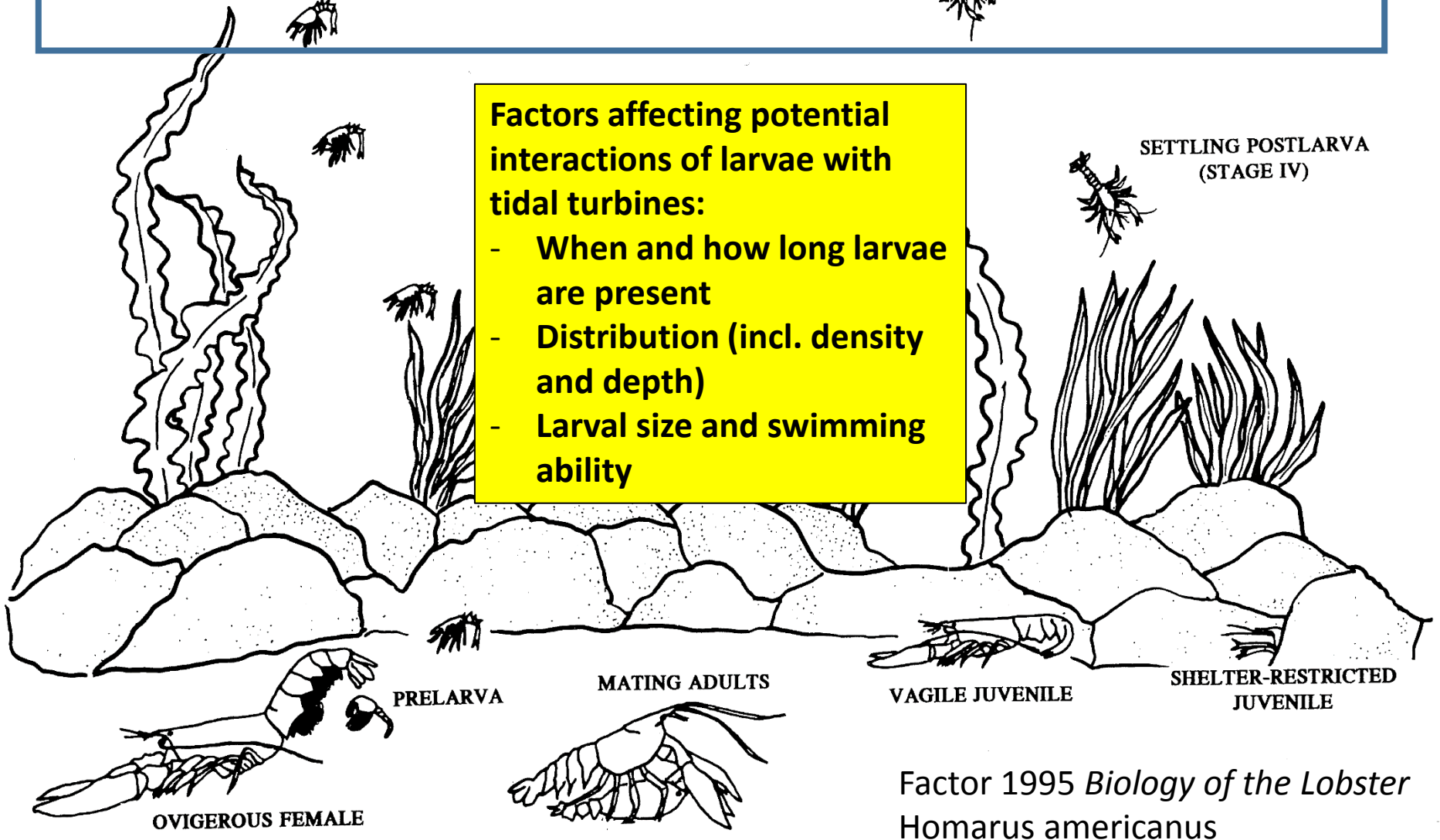
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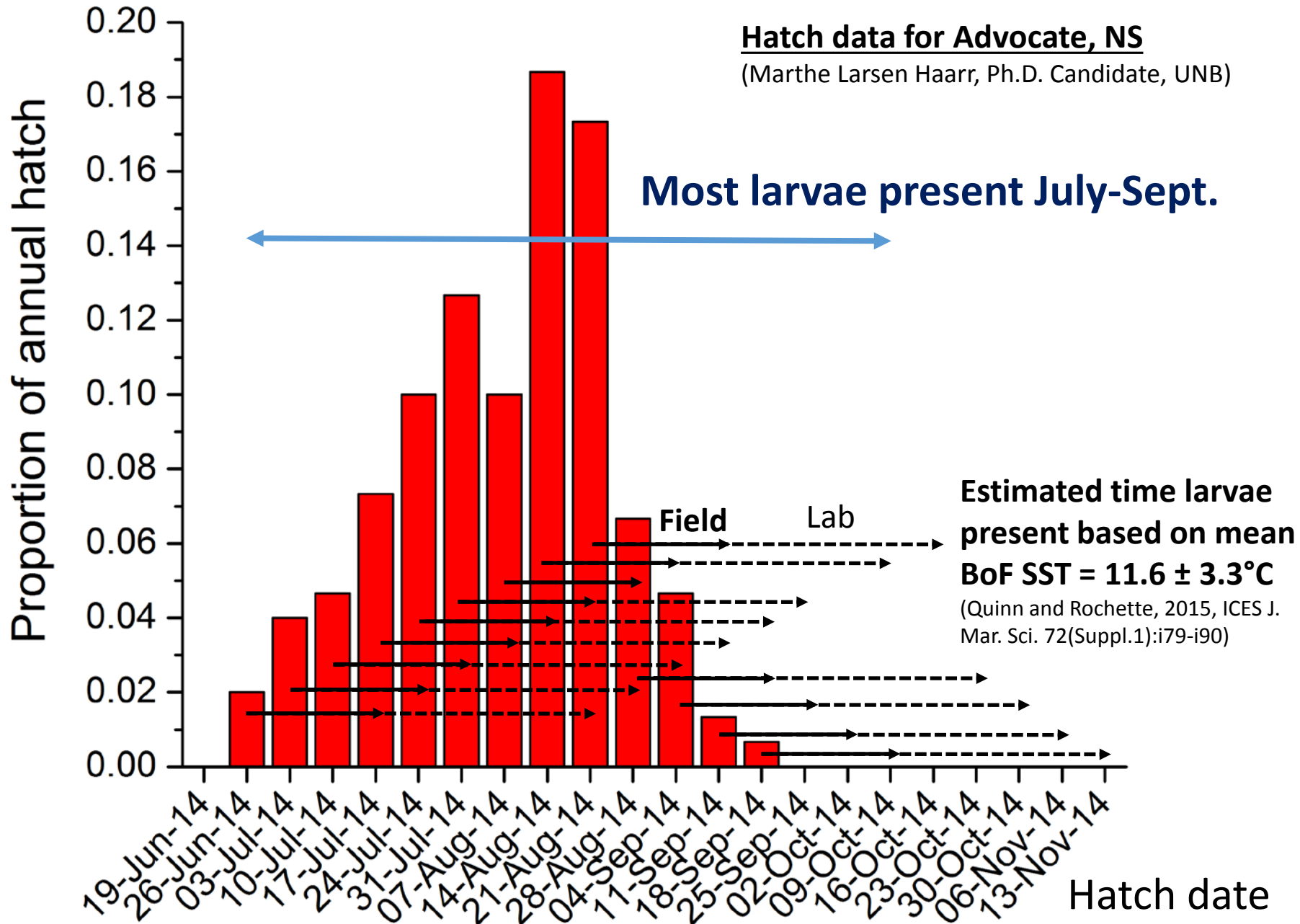
Factors affecting potential interactions of larvae with tidal turbines:

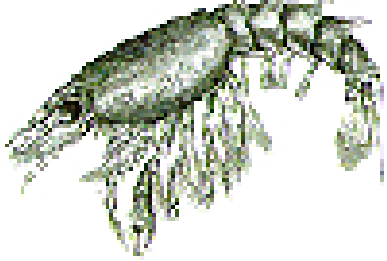
- When and how long larvae are present
- Distribution (incl. density and depth)
- Larval size and swimming ability



Factor 1995 *Biology of the Lobster Homarus americanus*

When are larvae present?

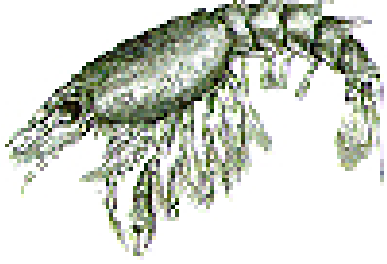




Larval distribution and density

- Usually assessed with plankton tows (no data for Minas Basin)
- Low and variable catch-per-unit-effort:
 - CPUE = 0.00026 to 53.4 larvae per h sampling effort (Sigurdsson et al. 2014 J Crustac Biol 34:182-188)
 - High natural mortality (est. $\gg 90\%$ total, $6-30\% d^{-1}$), perhaps due to predation (Incze et al. 2003 Fish Res 65:33-46) \rightarrow lower densities
- Vertical distribution variable, between surface and 30 m depth
 - Remain above thermocline if present (Harding et al. 1987 Mar Ecol Prog Ser 41:29-41) Or mainly at surface if mixed (Hudon et al. 1986 Can J Fish Aquat Sci 43:2164-2176)
 - Stage I at surface during day and deeper at night, stage IV at surface until settles, stages II and III stay deep (Stanley et al. 2016 Mar Ecol Prog Ser 553:125-146)
 - Mainly based on lab studies of behaviour or limited field tows, different studies disagree \rightarrow much uncertainty

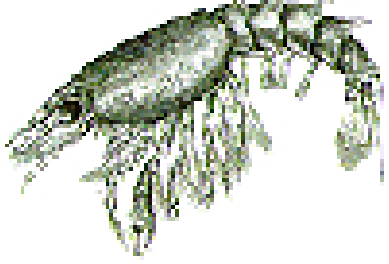




Additional considerations

- Larval size:
 - 8-15 mm total length depending on stage (Factor 1995)
 - Able to pass through turbine unharmed....? → Should be experimentally tested
- Swimming and sensory abilities of larvae:
 - Capable of sensing currents, pressure, temperature, etc. and reacting to these
 - Limited horizontal swimming ability ($2-6 \text{ cm s}^{-1}$) but able to move vertically with some competence (Stanley et al. 2016; Harding et al. 1987) → potentially avoid dangerous conditions (e.g., offshore dispersal)?
 - Specific cues and abilities uncertain beyond a few lab studies – need to confirm ability to avoid hazards in nature

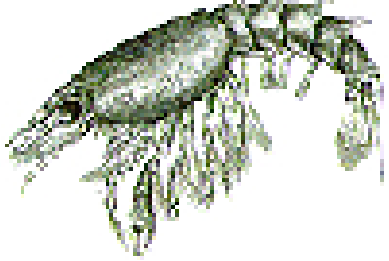




Summary

- Larvae small, present for a brief period, widely-dispersed, and maybe moving among depths
 - Perhaps small-scale operations would have minimal impact on lobster larvae and recruitment to fished populations?
- BUT data not currently available to sufficiently assess this risk
- Recommend caution with development and further study of:
 - Density of larvae in regions subject to tidal power development
 - Better understanding of larval behaviours and survival in nature
 - Will impact encounter probability, ability to avoid turbines, and relative impact of any mortalities on overall recruitment

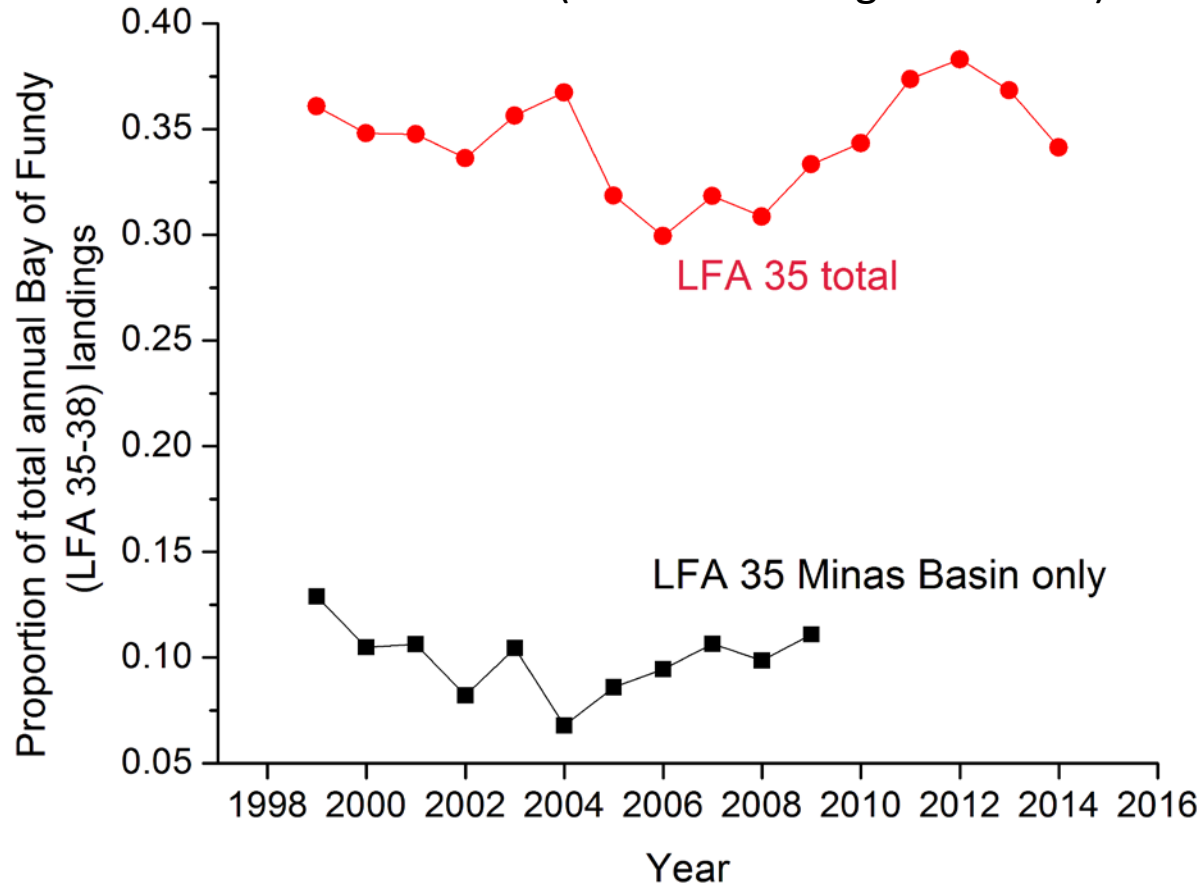


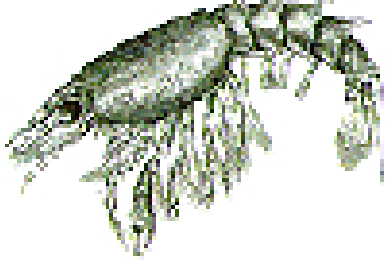


Implications?

LFA = Lobster Fishing Area
(fisheries management unit)

- ~10 % of Bay of Fundy lobster landings come from the Minas Basin (DFO, 2013)
 - ~1/3 of landings in LFA 35
 - Low risk to the Bay of Fundy at large?





Implications?

- LFA 35 (incl. Minas Basin) may supply on-average 30% of settlers to other fisheries in the Bay of Fundy (Quinn 2014 M.Sc. Thesis)
 - Potentially important connectivity via larval drift from Minas Basin
 - Preliminary estimates based on physics + limited biology, will be confirmed....

