Reproductive Impairment of a Salt Marsh Fish as an Indicator of Pollutant Effects

**Issue**
Organisms living in salt marshes are often exposed to environmental stressors derived from urban, industrial or agricultural activities, and these exposures may be continual, seasonal, or even just over a single tidal cycle. Resident marsh organisms have not been used for management of wetlands, and thus the health of endemic organisms in wetlands is largely unknown. Exposure of organisms to chemical stressors can be through sediment and water, as well as food exposure routes. Organisms living within the marsh channels and plains that integrate exposures and effects of contaminants are excellent indicators for determining the impacts of contaminants on resident species, without the extrapolations inherent in toxicity testing and other common methods currently in use.

**Approach and Rationale**
Our approach has been to establish a direct link between contaminants and reproductive impairment using a ubiquitous resident fish. In order to test the broad applicability of this approach, we tested this in five California marshes over 600km of coastline. Integrating biological responses of exposure to contaminants at the level of reproduction provides a direct link to predicting population level effects of stressors. (Link to Modeling: Value Added)

**Findings and Impact**
The longjaw mudsucker, *Gillichthys mirabilis*, is a gobid fish that is common to salt marshes in California. It is an extremely hardy species that occurs even at contaminated sites. *Gillichthys* spends its entire juvenile and adult life within the same marsh, and typically lives within a 30-50 m home range. They establish mud burrows in the banks of channels within the marsh, and this is also where reproduction occurs. Reproductive impairment was a sensitive indicator of habitat condition in the salt marshes studied, and classic reproductive impairment, as well as endocrine disruption, were observed.

- Males can be distinguished from females based on jaw length (Figure 1), enabling identification of sex without sacrificing fish, which is critical for studies of endocrine disruption.

- Males and immature fish from more contaminated sites showed the abnormal endocrine disruption response of choriogenins (or egg coat proteins) circulating in their plasma based on the use of a standardized antibody response. This response is considered normal only in sexually developing females. (Link to Fish Endocrine Disruption)

- Fish from contaminated sites showed an increased incidence of ovotestes (also known as intersex) where both ovarian and testicular tissues were present. (Link to Fish Endocrine Disruption)

- The ovaries from fish from contaminated sites showed both an increased incidence of tumors and an increased incidence of apoptosis or programmed cell death, a cellular response to toxic insult in which damaged cells are removed from the tissue in an attempt minimize the incidence of tumor formation. (Link to Fish Apoptosis)
Findings and Impact, cont.

• Suites of indicators can be integrated using multivariate statistics to characterize the percentage of fish in a marsh with impaired condition. (Link to Fish Integrated Indicators)

• We propose that this approach can be used in a standard portfolio of indicators to identify “at risk” wetlands and to assess their overall condition. This may be most valuable for marsh restoration and mitigation, as well as for selected Total Maximum Daily Load (TMDL) applications.

Applications

• Reproductive impairment in the mudsucker is a valuable tool for assessing the health of salt marshes, and their highly limited home range provides a means for establishing a map of fish health at specific stations within a marsh. (Link to Fish Integrated Indicators)

• The assessment of endocrine disruption in mudsuckers is rapid, and sampling can occur in the field or the laboratory. In addition, individuals can be repeatedly sampled in order to assess temporal responses. (Link to Fish Endocrine Disruption)

• The contaminants responsible for endocrine disruption, as well as reproductive impairment, can be investigated once the biological responses within a marsh are established. (Link to Fish Endocrine Disruption)

• This general approach has been validated at several sites in California but its applicability for issues relating to specific contaminant stressors or restoration actions may require refinement of the overall approach.

Publications


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