The effects of dredging on fin fish.
Acknowledgments

Woodside, Chevron and BHP and WAMSI partners for funding this research.

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Activities

1) Workshop
   ◦ 31 October to 1 November 2013

2) Literature review

Objective

a) Assess the known effects of dredging on fin fish
b) Assess gaps in knowledge in Western Australia
c) Identify and prioritise future areas of research

Context - Critical Environmental Windows
Potential stressors

1. Hydraulic entrainment of fish eggs, larvae, juveniles and adults
2. Increased suspended sediments and turbidity
3. Resuspension of buried contaminated sediments which may release toxins and nutrients that can have acute or chronic effects on fish
4. Loss of fish habitat through sedimentation, removal or degradation
5. Increased noise
6. Introduction of marine pests
Increased Suspended Sediment 1

1. Behavioural changes
   a) Avoidance (- CPUE Atlantic Sturgeon, disappearance of Mackerel from spawning grounds)
   b) Impaired visual acuity and chemoreception
      i. Damsel fish unable to locate coral (Wenger et al 2011, Wenger McCormick 2013)
      ii. Foraging impacts planktivorous, herbivorous, and piscivorous fishes

2. Physiological changes
   a) Gill flaring and increased coughing (Any reduction in gill efficiency can impair respiratory ability, nitrogenous excretion and ion exchange)
   b) Direct damage to gills (elevated pathnogenic bacteria)
      Can strongly influence growth and development and swimming ability
Effects of released contaminants on fish

Metals (copper, zinc, nickel, lead, cadmium), Non-metallic inorganics,

Organotins (e.g. Tributyltin)

Hydrophobic Organic Contaminants (persistent organic pollutants including polychlorinated biphenyls, polybrominated diphenyl ethers, organochlorine pesticides, dioxins and furans)

Have been documented to impact reproductive output and early development in fish:

a) reduce sperm motility
b) cause developmental delay, changes in time to hatch and larval deformity
c) Higher concentrations of ionic metals are lethal to significant proportions of larvae
d) Reduced fitness of adults
Hydraulic entrainment

Entrainment is the direct uptake of aquatic organisms by the suction field generated at the draghead or cutterhead during dredging operations

1. Direct entrainment of eggs or larvae
2. Direct entrainment of juveniles
3. Direct entrainment of adults
4. Trophic cascade effects of entrainment of sediment associated prey species
Traits which make fish vulnerable

Benthic spawners
Demersal eggs
Fish which target highly mobile prey
Fish from clear water environments
Fish which have a small home range
Fish which occupy vulnerable habitats that are restricted in area

Long pelagic larval duration
Fish which are visual feeders
Benthic dwelling fish
Fish with specific habitat associations
Fish which are scraping herbivores
## Gap analysis (102 species)

<table>
<thead>
<tr>
<th>Fish Family</th>
<th>Time of year</th>
<th>Duration</th>
<th>Habitat</th>
<th>Pelagic larval or propagule duration</th>
<th>Aquatic zone</th>
<th>Time of year</th>
<th>Duration</th>
<th>Habitat</th>
<th>Aquatic zone</th>
<th>Bioregions</th>
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<tr>
<td>Arripis</td>
<td>Apr-Jun (peak late May/early Jun)</td>
<td>3 months</td>
<td>West Coast Bioregion only, Reef, sand, weed</td>
<td>Variable between regions-increases with distance from spawning area</td>
<td>Es, Ns</td>
<td>Jun-Sep (variable between regions-increases with distance from spawning area)</td>
<td>4 months-Variable between regions-increases with distance from spawning area</td>
<td>Shallow nurseries with vegetation</td>
<td>Ns</td>
<td>GCB, WCB, SCB</td>
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<td>A.truttaceus</td>
<td>Feb-Jun (peak Apr/May)</td>
<td>5 months</td>
<td>Southern part of West Coast Bioregion</td>
<td>u</td>
<td>Ns</td>
<td>u</td>
<td>u</td>
<td>Soft substrate, shallow sheltered bays</td>
<td>Es, Ns</td>
<td>WCB, SCB</td>
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<td>Centrobryx gerrardi</td>
<td>Jan-Apr</td>
<td>4 months</td>
<td>Aggregations, Reef</td>
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<td>In</td>
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<td>u</td>
<td>WCB, SCB</td>
<td>Preliminary data</td>
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Gap analysis continued

Spawning

a) Spawning periods for 60 (59%) fishes

b) Duration of spawning for 58 species (57%)

c) Pelagic larval duration 18 species (17%)

d) Very little information on spawning locations and habitats

Recruitment

a) Time of year 11 (11%) fishes

b) Duration of recruitment for 7 species (7%)

c) Recruitment locations and habitats for 16 species (16%)
Spawning and Critical Environmental Windows

Spatial variation in spawning

Eg  Pink Snapper (*Chrysophys auratus*)

Shark Bay  = April to October

Perth = August to January

Albany = September to December
Prioritisation process – how do we decide

Sensitivity index Stekzenmuller et al. 2012

1. Geographical distribution: species with restricted distributions have the highest sensitivity score.

2. Threat status: determined using the IUCN redlist.

3. Importance to fisheries – economic importance to commercial fisheries (price × weight landed).

4. Habitat vulnerability: proportion of habitat vulnerable to dredging with information on habitat position and type and species usage of these habitats.

5. Ability to switch diet: examination of the species trophic guild and the impact of aggregate extraction on its prey.

6. Affinity to seabed: consideration given to species habitat and speed of movement.

7. Reproductive Strategy: position of eggs, position of post-larval stage and fecundity.
# Prioritisation process – how do we decide

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<th>Scientific name</th>
<th>Common name</th>
<th>Economic significance</th>
<th>Recreational significance</th>
<th>Customary significance</th>
<th>Social significance</th>
<th>IUCN/EPBC significance</th>
<th>Recruitment (year class resilience) significance</th>
<th>Distribution/endemism significance</th>
<th>Connectivity significance</th>
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</table>
Research priorities

Identify species of concern

Spawning, Recruitment and effects of dredging

1. What are the spawning times, duration and spawning locations?
2. What is the spawning behaviour (ie single schools at one location)?
3. When does recruitment occur for species of concern and into what habitats?
4. Is the timing of recruitment the same across the entire range of a species?
5. What is the availability (area) of essential habitat throughout the recruitment range?
6. What are the effects of sediment and noise on the larvae, recruits and adult life stages?

Questions?