



**Effects of Oil Pollution on
the Red Mangrove,
Rhizophora mangle L.**

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MBF 602 Seminar

Comparison of Physical Properties of Fuel oil 6 and Orimulsion™

Physical Property	Fuel oil 6 (=Bunker C)	Orimulsion™
origin	Refinery by-product after fractional distillation.	Unrefined, naturally occurring bitumen emulsified in water.
water content (% wt)	0.1	29.5
pour point (°C)	15	3
density at 15°C (g/cm ³)	0.983	1.0123
flash point (°C)	-	>95
vapour pressure at 25°C (psi)	-	0.25
volatility	high	low
droplet size (µm)	-	17
behavior in water	floats at both 0 and 35ppt salinity	floats at 35ppt salinity, but sinks at <5ppt

Comparison of Chemical Properties of Fuel oil 6 and Orimulsion™

Chemical Property	Fuel oil 6 (=Bunker C)	Orimulsion™
origin	Refinery by-product after fractional distillation.	Unrefined, naturally occurring bitumen emulsified in water.
surfactant	none	0.17% by wt of 4-nonyl phenol polyethoxylate
Sulfur (% wt)	-	2.8
average MW	200-300	638
saturates (% wt)	26	17
aromatics (% wt)	52	47
resins (% wt)	12	16
asphaltenes (% wt)	10	20
volatiles (benzene, naphthalene, PAH's)	30.5	<5
benzo [a] pyrene (a carcinogen)	high	low
BTEX fraction (mg/kg)	464-852	45 - 176

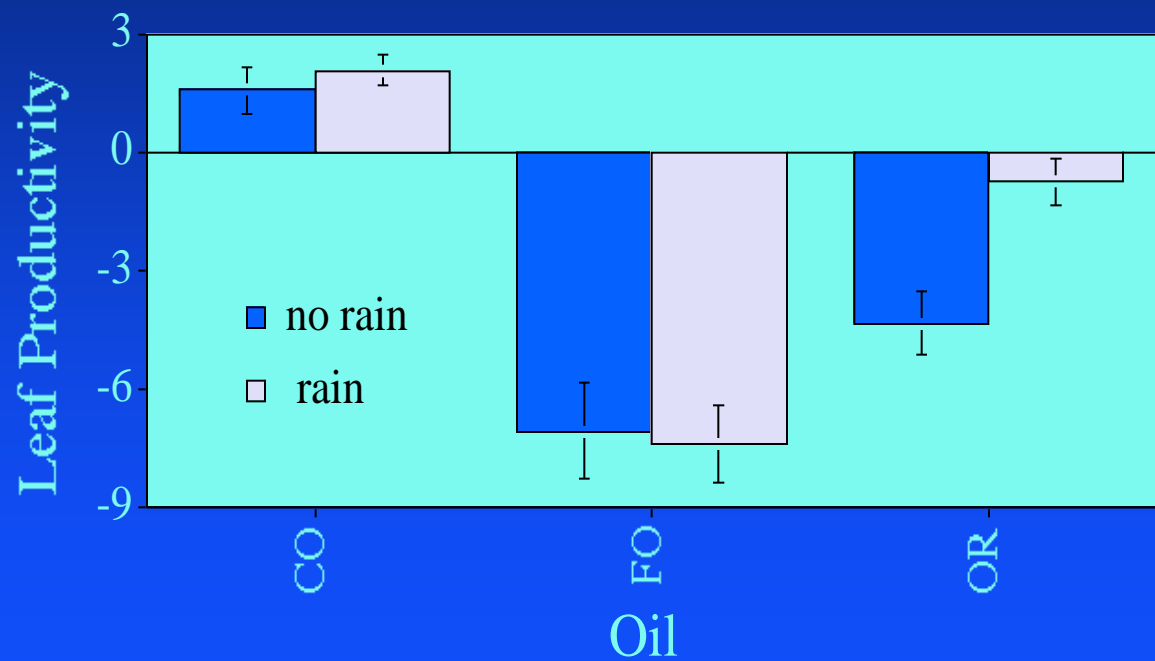
Outline of Experiments on Mangroves (Task 4b)

- 1. Floating propagule experiments
- 2. Propagule stranding experiments
- 3. Aerial dosing experiment
- 4. Sediment dosing experiment

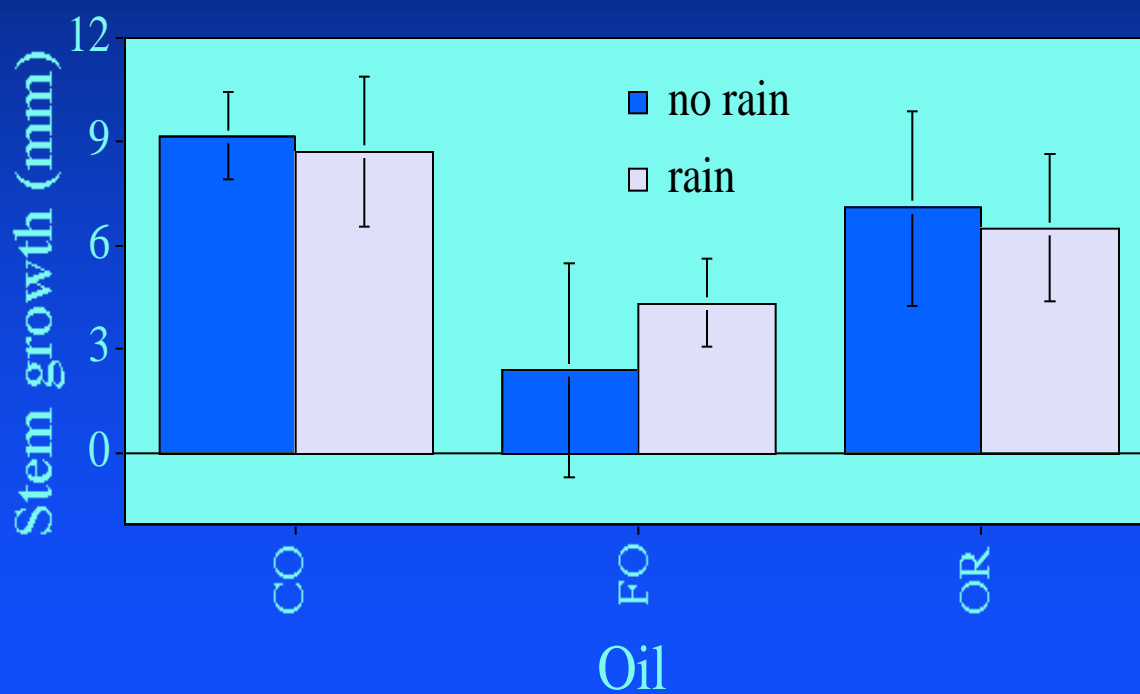
Aerial Dosing Experiment

- ▶ Aim: Simulate the coating of seedlings by oil carried onshore during tidal flux.
- ▶ Dosing concentration: 10:1 water:oil mixture.
- ▶ Rain and No Rain treatments
- ▶ Measurement protocol (n= 6):
 - ▶ Weekly measurements of leaf loss/production and shoot elongation.
- ▶ Duration = 8 weeks

Aerial Dosing: Leaf production/loss



Aerial Dosing: Stem growth



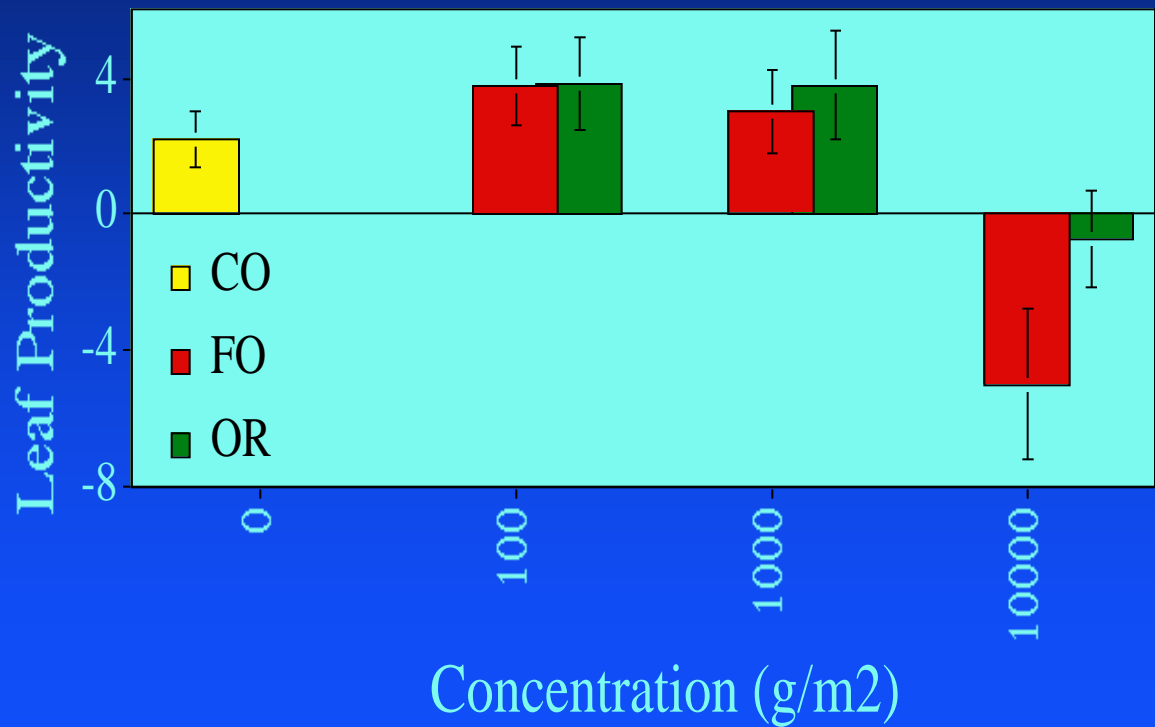
Summary Aerial Dosing Results

- ▶ Fuel oil 6 is more detrimental than OrimulsionTM for both measured variables (leaf productivity and stem growth).
- ▶ Treatment after oiling (rain vs. no rain) was not significant in mitigating against the effects of the oil.

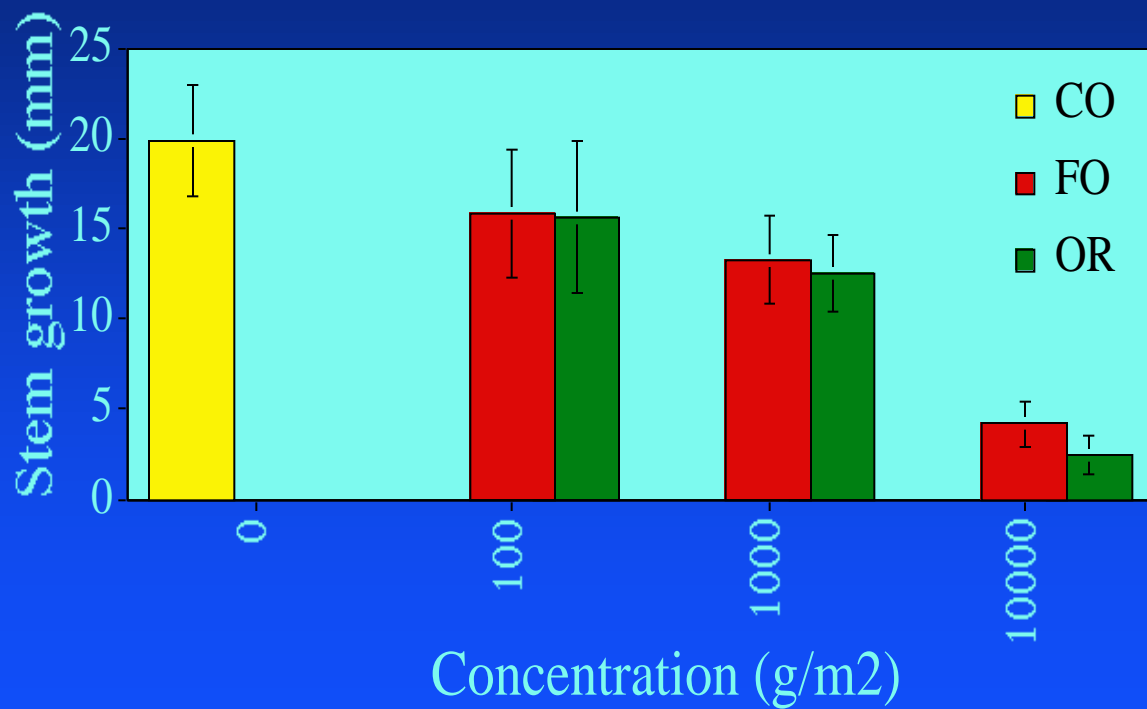
Sediment Dosing Experiment

- ▶ Aim: Simulate the effects of stranding and trapping of oil in intertidal mangrove sediments.
- ▶ Dosing range: 0, 100, 375, 650, 1000, 2500, 5000, 10'000 g/m²
- ▶ Measurement protocol (n=10-15):
 - ▶ Weekly measurements of leaf loss/production and shoot elongation.
 - ▶ Monthly measurements of leaf length, width and thickness (with comments on leaf damage), and internode lengths.
 - ▶ Monthly measurements of leaf stomatal conductance and chlorophyll *a* fluorescence induction.
- ▶ Duration = 20 weeks

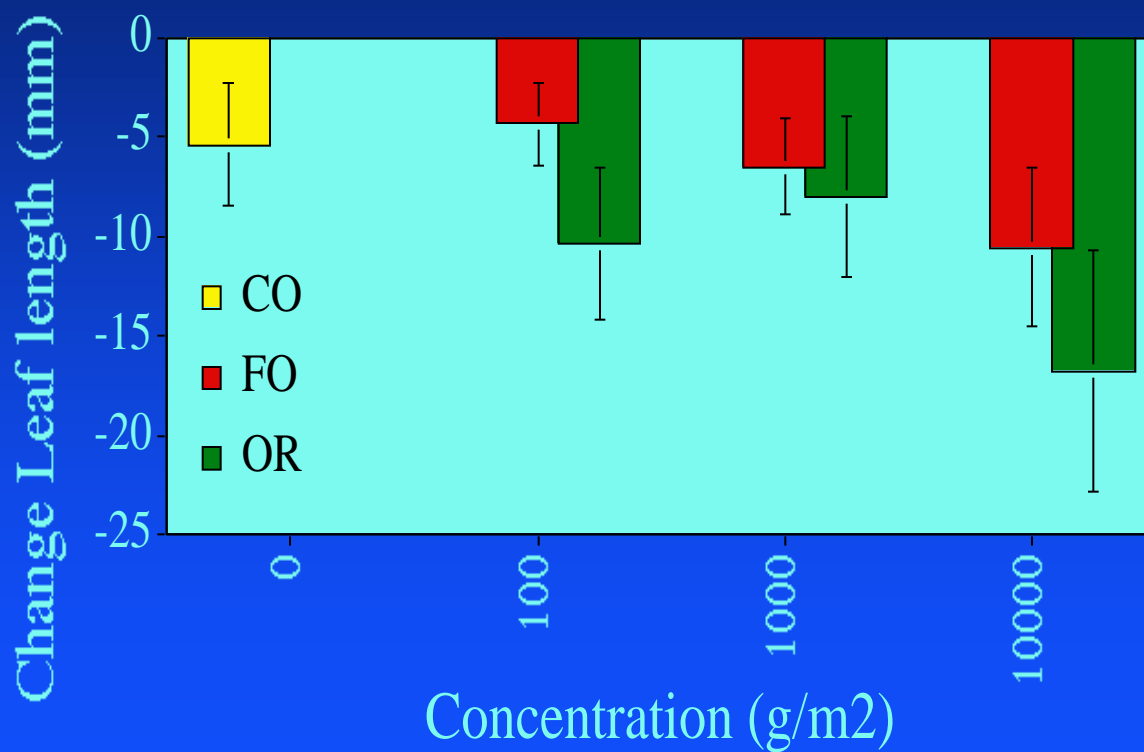
Sediment Dosing: Leaf production/loss



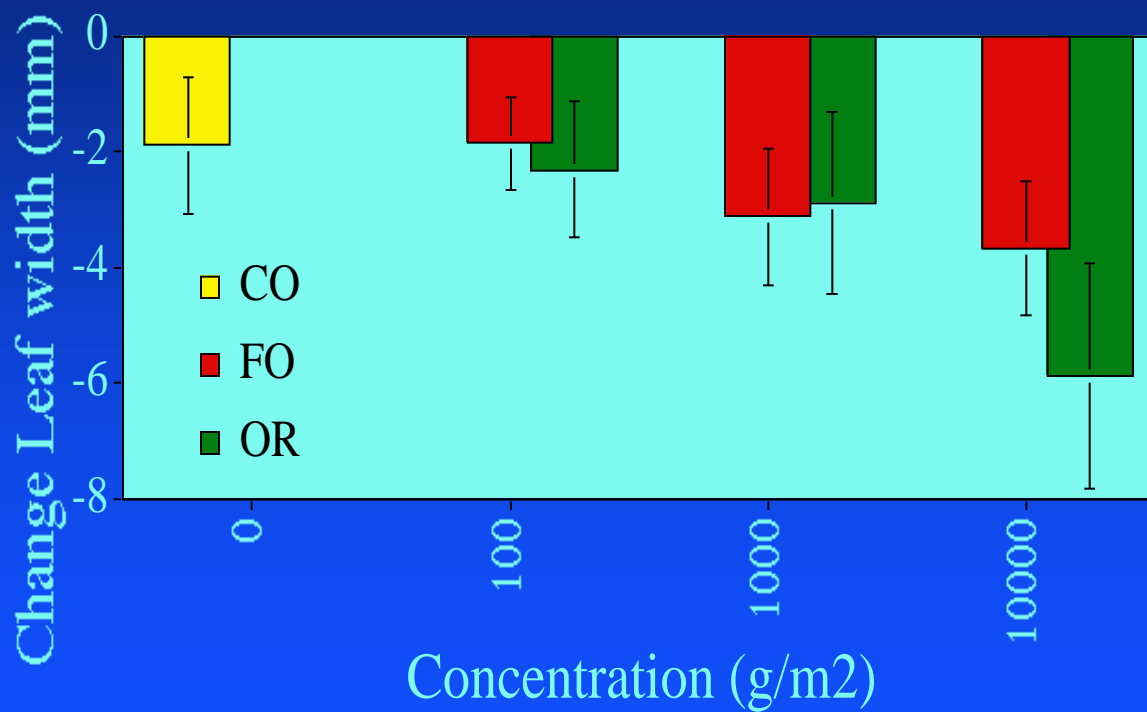
Sediment Dosing: Stem growth



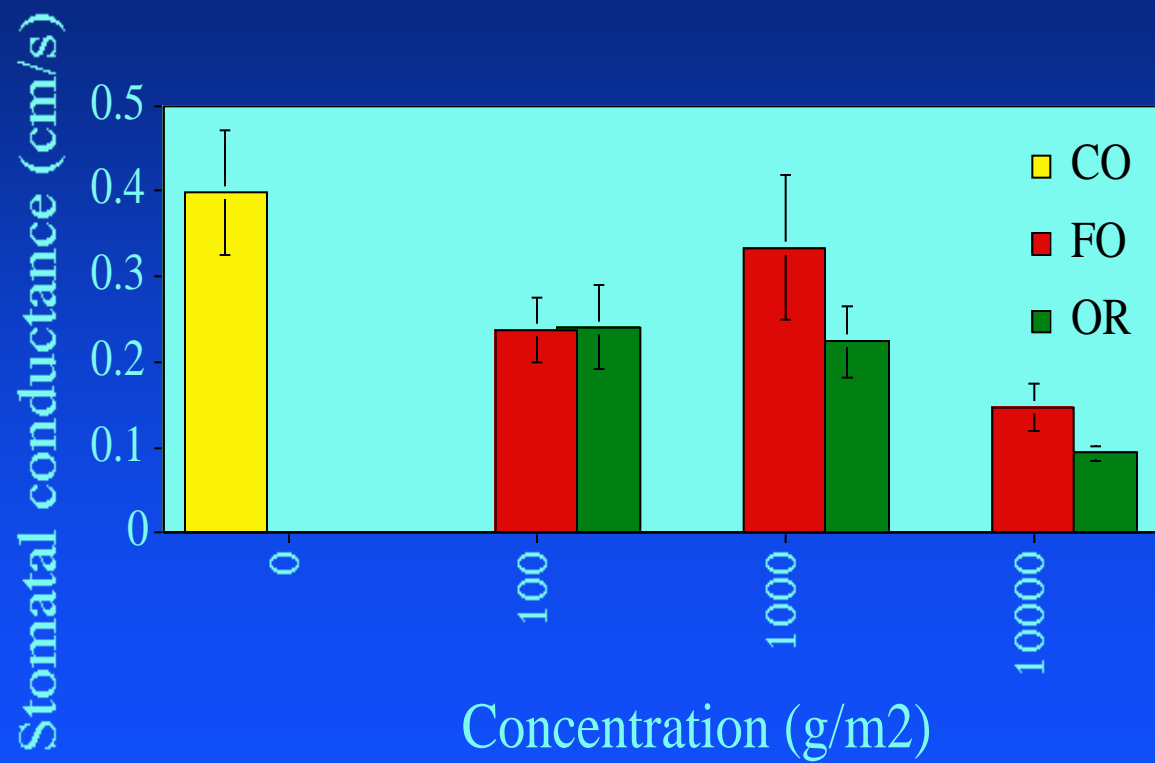
Sediment Dosing: Leaf length



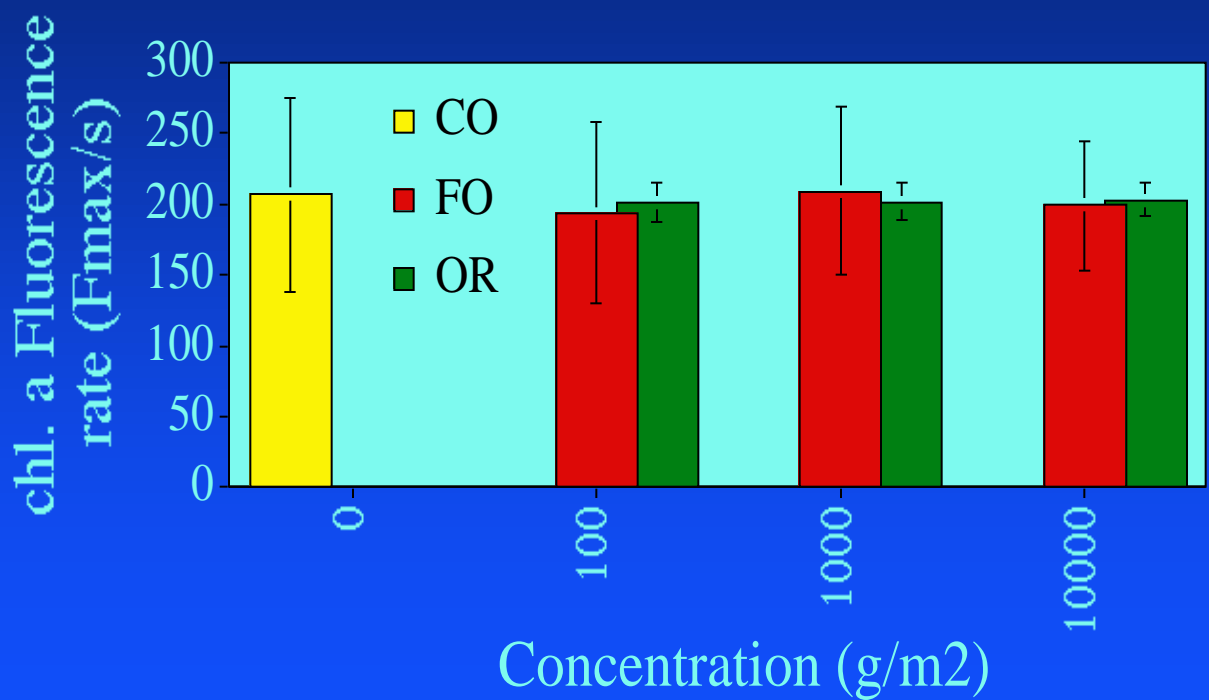
Sediment Dosing: Leaf width



Sediment Dosing: Stomatal conductance



Sediment Dosing: Chlorophyll *a* fluorescence induction



Summary Sediment Dosing Results

- ▶ Leaf productivity was similar for both oils. Productivity appears to be stimulated at intermediate concentrations (100 & 1000 g/m²), but is significantly reduced at 10'000 g/m²
- ▶ Stem growth is a sensitive indicator of concentration for both oils.
- ▶ Leaf length and width are reduced in a concentration dependant manner, and OrimulsionTM has a greater adverse effect on these parameters than Fuel oil 6.
- ▶ Stomatal conductance decreases with increasing concentration, indicating physiological stress. OrimulsionTM has a significantly greater impact at higher concentrations than Fuel oil 6.
- ▶ Adverse effects on photosynthetic ability are not evident for either oil.

Summary

➤ Aerial dosing experiment:

Refugee OrimulsionTM entrained in tidal water washing over seedlings is not likely to have any detrimental effect on normal growth and development, whereas Fuel oil 6 can cause significant acute mortality.

➤ Sediment dosing experiment:

Seedlings exhibited adverse effects proportional to oil concentration for most variables. Plants exposed to OrimulsionTM fared slightly better than those exposed to Fuel oil 6. No acute mortality occurred.

➤ Floating and stranded propagule experiments:

Propagules floating in Fuel oil 6 failed to exhibit any of the steps associated with normal development. In contrast development in those floated in OrimulsionTM was stimulated compared to controls.

Conclusions

**Direct or indirect exposure to
refugee OrimulsionTM will not
have any serious or
consequential impact on
mangroves.**