Acute and population level effects of exposure to dispersant, oil and dispersed oil on multiple life history stages of *Eurytemora affinis*.

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Background

- Ideally, marine oil spill response involves the integration of all available, effective, and environmentally acceptable techniques.
- In the United States (and many other countries), the primary response options are:
  - On-water mechanical recovery
  - Shoreline recovery

Background (cont.)

- There are disadvantages to both of these:
  - On-water mechanical recovery is often ineffective, especially in open water.
  - Shoreline recovery does not prevent the initial damages to both surface water and shoreline resources.
- The only viable alternatives that can be implemented early in a spill event are dispersant use or (less frequently) on-water *in-situ* burning.

Examples of shoreline cleanup – tanker barge Bourchard spill in Tampa Bay , FL

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Examples of on-water skimming in Alaska and in Galveston Bay

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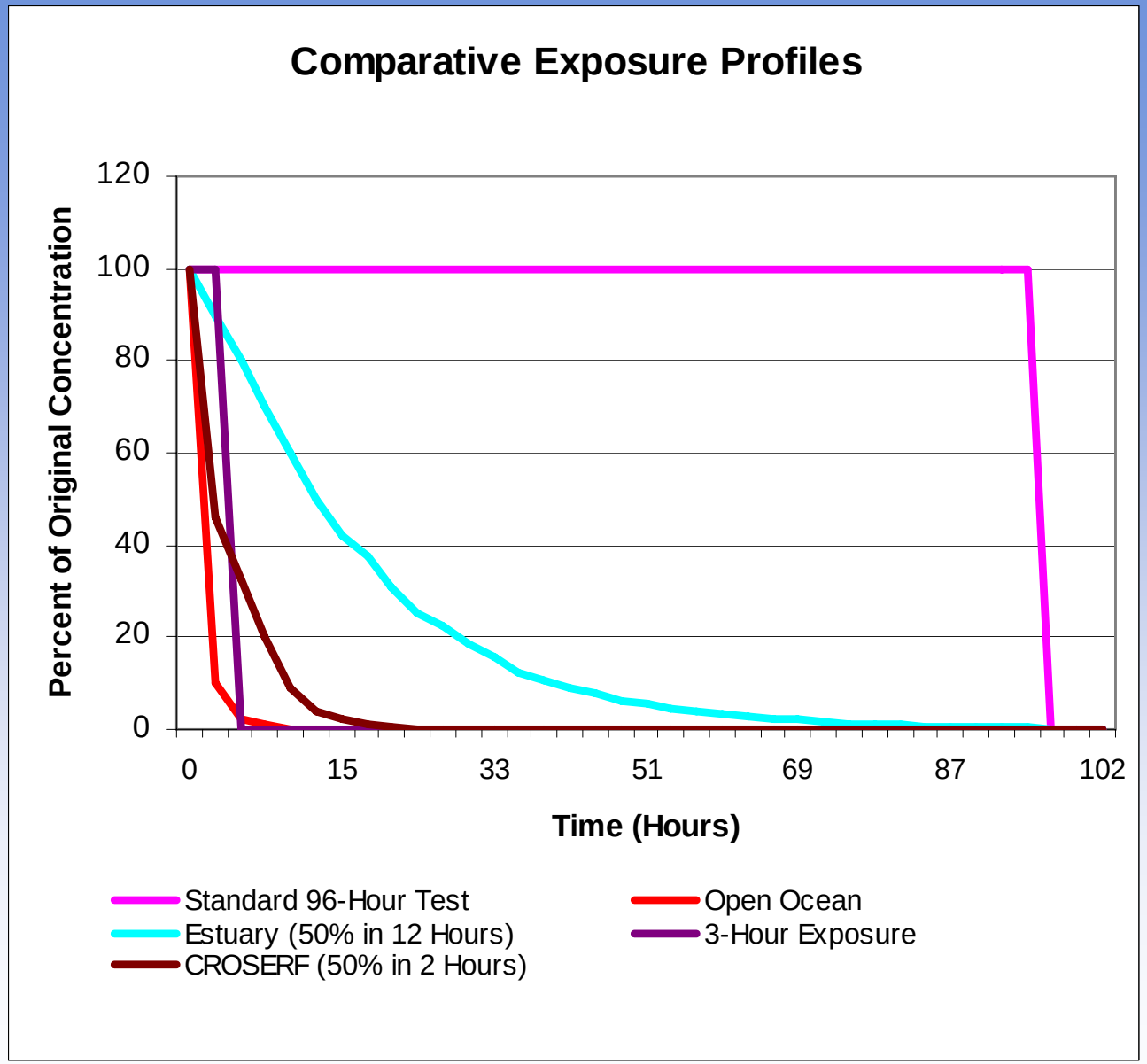
Background (cont.)

- Consideration of dispersant use in response to oil spills involves the evaluation of environmental tradeoffs.
  - Proponents of dispersant use generally dismiss potential impacts to sensitive water column organisms based on rapid dilution.
  - Possibility of sublethal effects of exposure to dispersant or dispersed oil leading to population level effects is a serious concern for many natural resource managers when this approach is suggested.



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Background (cont.)

- Available laboratory data
  - Almost entirely acute toxicity information.
  - Exposure profiles rarely reflect expected exposures.
  - Only occasional studies which examine sublethal endpoints.
  - No studies which examine multi-generational consequences of potential short-term sublethal effects.
- Leads to controversy when dispersant use is proposed.

Project Objective

- Evaluate the relationship between laboratory toxicity tests, expected field exposures and possible population level effects of dispersant and dispersed oil
  - Use multiple life history stages.
  - Use a ubiquitous, easily cultured planktonic species.
  - Use realistic exposure regimes.
  - Use protocols which allow comparisons to existing data sets.

Experimental Design

- Test organism – *Eurytemora affinis*.
  - Estuarine copepod.
  - Can tolerate a wide range of salinity/temperature combinations.
  - Some relevant data already available.
- Use existing protocols developed by state/federal/industry workgroup (CROSERF) to allow for comparison to existing data.
- Use declining exposure regimes.

Experimental Design (cont.)

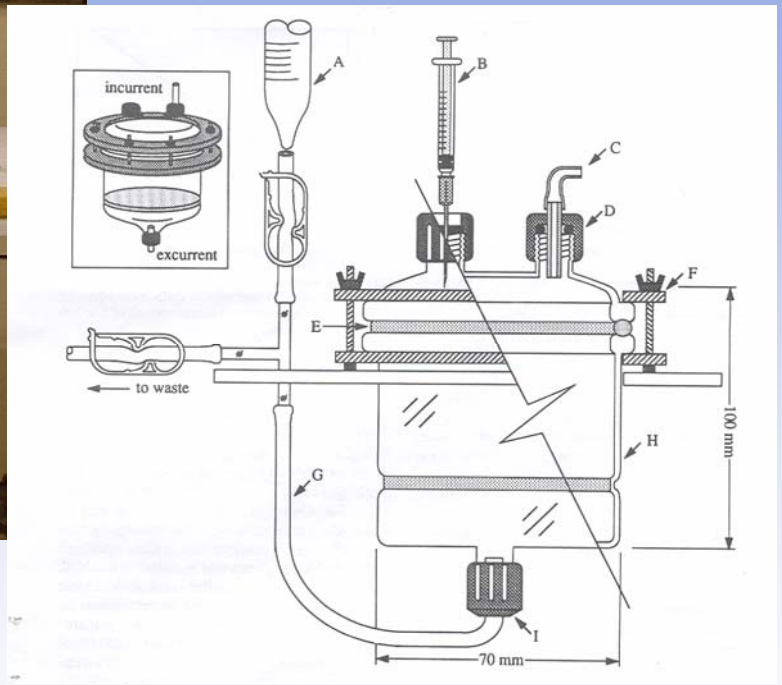
- Obtain 96-hour LC50 values for nauplii, late stage copepodites, and mature adults.
  - Dispersant alone.
  - Water Accommodated Fraction (WAF) of weathered Alaskan North Slope (ANS) crude oil.
  - Chemically enhanced WAF (dispersed oil) of weathered ANS crude oil.
- Expose nauplii, copepodites and adults to the LC50 concentration (initial level) in a declining exposure for 48 hours.

Experimental Design (cont.)

- Remove surviving organisms and transfer them to grow-out culture chambers where they are maintained in clean culture water for 30 days.
  - 18 chambers (9 with treated animals, 9 with control).
  - Determine the number of each life history stage in one chamber every 6 days, count the last five chambers on day 30.

Experimental Design (cont.)

- Repeat exposure and grow-out experiments in the presence of UV light.
- Use all three life history stages.



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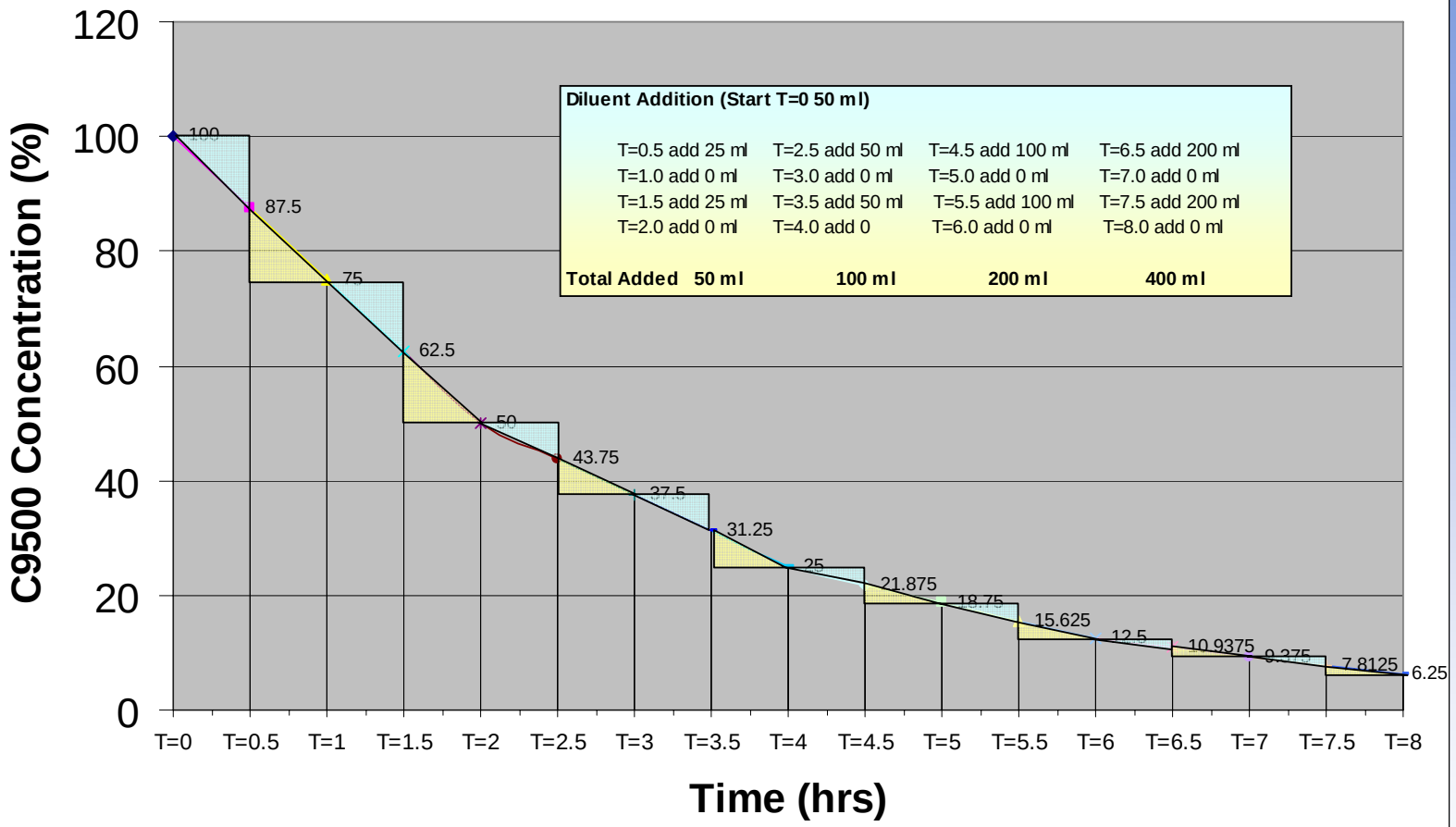
Experimental Challenges

- Nauplii and younger copepodites cannot be used in flow-through chambers.
  - Apparently they become entrapped in the sintered glass bottom.
- Needed to develop a static dilution series.
  - Addition of clean seawater to create a curve similar to the flow-through system.

Stepped Declining Concentration Protocol



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Results to Date

- Fecundity Studies
  - 3 gravid females for 30 days

Replicate	Nauplii	Copepodites	Adults	Gravid Females	Total
1	215	214	118	8	555
2	188	288	102	4	582
3	206	223	106	11	546
4	231	252	104	8	595
5	175	227	146	5	553

Toxicity Results – Corexit 9500 in a Static Stepped-Decline Exposure

Life History Stage	LC50 (ppm)	95% CI (ppm)
Nauplii	7.2	6.1 to 8.5
Copepodites	10.1	7.6 to 13.3
Adults	29.8 21.4	24.3 to 39.4 15.5 to 29.6

Flow-Through versus Static Dilution Using Adults and Dispersant (LC50)

Static Stepped Decline Exposure	Flow-Through Spiked Exposure
29.8	85.0
21.4	74.4*

* Animals used in grow-out experiment.

Preliminary Fecundity Study After Flow-Through Spiked Dispersant Exposure

Exposure (ppm)	Nauplii	Copepodites	Adults	Gravid Females	Total
0	86	10	65	4	165
0	63	3	34	7	107
51	49	0	57	11	117
51	83	1	42	4	129
30-Day Grow-Out Period					

Constant 96-Hour Toxicity Results with Adult Copepods

- Given the differences in declining exposure results for the two protocols, we compared constant exposure results with the same systems.
- Flow Through Constant Exposure LC50 (CROSERF).
  - 5.2 (5.0 to 5.6 CI) ppm.
- Static Stepped-Dilution Constant Exposure LC50.
  - Could not calculate (poor survival at all exposures).
- This suggests that the two exposure methods are not equivalent – so our results cannot be directly linked to previous CROSERF studies.

Future Work

- Redesign exposure regime (proposed changes):
  - Adopt a static 24 and/or 48 hour exposure protocol.
  - Do not attempt to link results to previous CROSERF data.
- Redo data on dispersant only to relate to existing results.
- Use new protocols for:
  - Water-Accommodated Fraction of weathered oil LC50s.
  - Chemically-enhanced WAF of weathered oil LC50s.
- Multi-generational grow-out experiments
- Effects of ultraviolet light.