Assessing the effects of mosquito control pesticides on non-targeted organisms in the Florida Keys National Marine Sanctuary

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Lobster larvae toxicity studies & Field Sampling

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Coral larvae toxicity studies

Unique Public-Private Partnership

Stakeholders from Federal, State & Local Agencies and Mote, an Independent Non-profit Research Institution

Project-Specific Goals

1. Determine if applications of mosquito control pesticides in the FKNMS affects other organisms.

   - early life stages and metamorphosis of coral and spiny lobster
   - pesticide distribution, concentration, transport, persistence
   - 3 pesticides

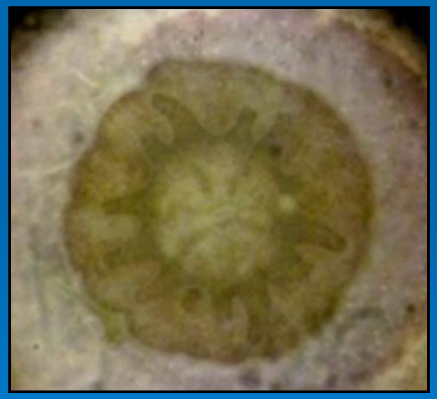
- **Permethrin:** Applied as Permanone 30-30 (30% Permethrin, 30% Piperonyl butoxide); PM Ground ULV
- **Malathion:** Applied as Fyfanon ULV Mosquito, 96.5% Malathion; PM ground ULV

- **Naled:** Applied as Dibrom Concentrate, 87.4% Naled; AM Aerial ULV

Application of Results

Provide FKNMS and FKMCD with empirical data to:

- **Preserve and enhance the living resources of the FKNMS**
- **While maintaining adequate mosquito control to protect the public health and economic well being of the FL Keys**



Coral larvae

Porities astreoides

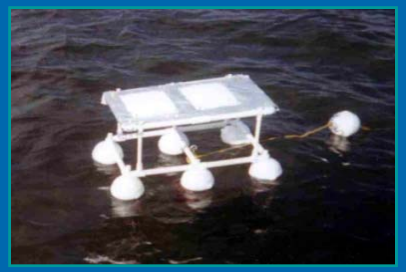
Puerulus

Panulirus argus

Relevant literature
Acute toxicity (96 hr LC-50)

Pesticide	96 hr LC-50 µg/L (ppb)		Half life (days)	Solubility mg/L (ppm)
	M. bahia	*P. duorarum*		
Permethrin	0.02-0.10	0.2	1-3	0.006
Naled	4.7-8.8	1.8	<1	2000
DDVP	19	-	<1	-
Malathion	2.2	280	<1	130

References:
Schimmel et al. 1983, Cripe 1994,
Mason and Wendel 2010, Faria et al. 2010

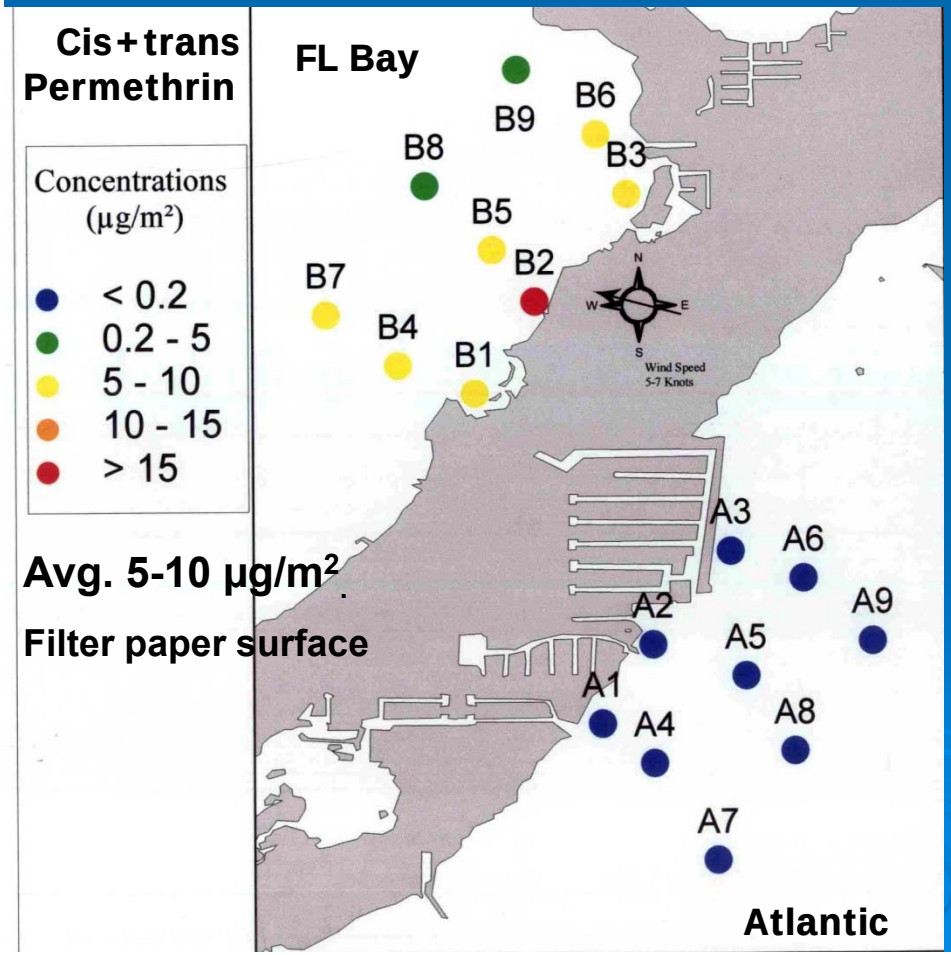


Previous pesticide monitoring

Pierce et al., 2005

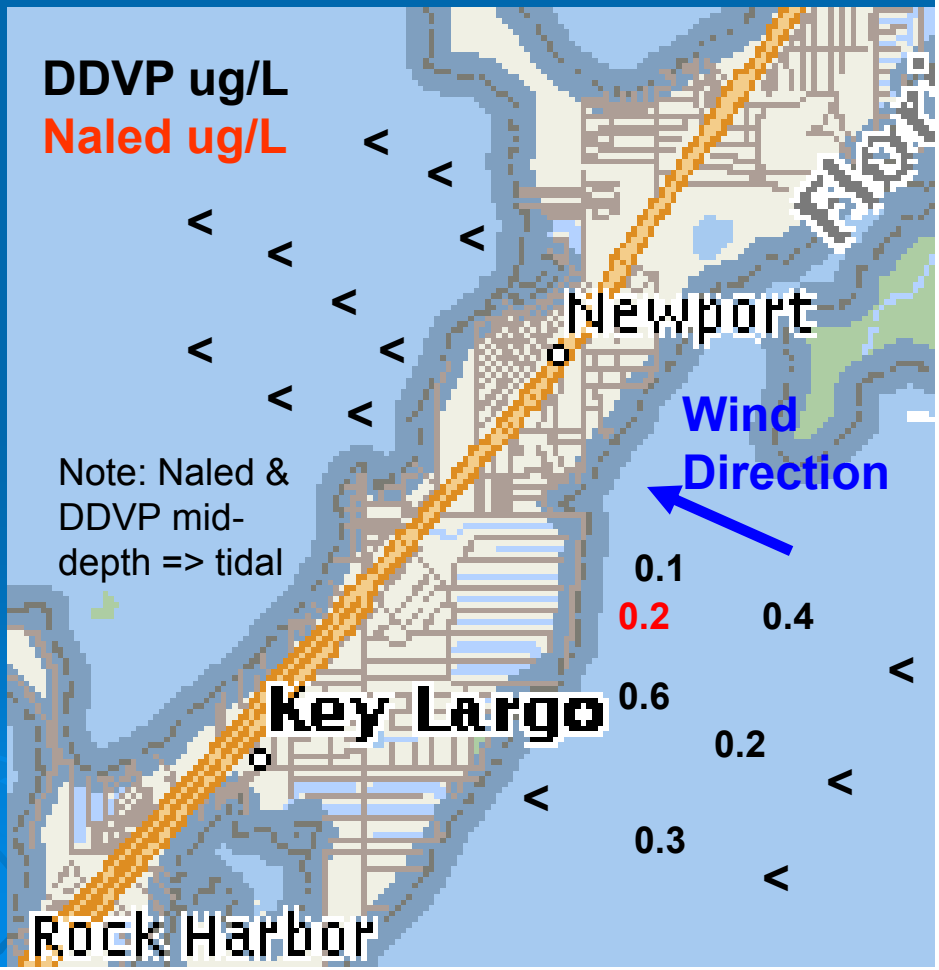
Permethrin: Drift Deposition on filter pads @ 2-4 hours after application
None detected in water

Naled, DDVP: Mid-depth Water @ 2 to 4 hr = tidal transport



Avg. 5-10 µg/m².

Filter paper surface



Lobster Larvae Toxicity Tests

T. Matthews, G. Renchen and B. Danson, FWC

Spiny lobster (*Panulirus argus*) exposed to environmentally relevant concentrations of Naled, Permethrin and Malathion in technical formulations.

Toxicity end points will include:

- Acute toxicity, LC-50, 96 hr.
- Developmental toxicity for pueruli and first-stage juveniles through critical stages of metamorphosis

Phyllosome Larvae

Puerulus Post Larva

Juvenile

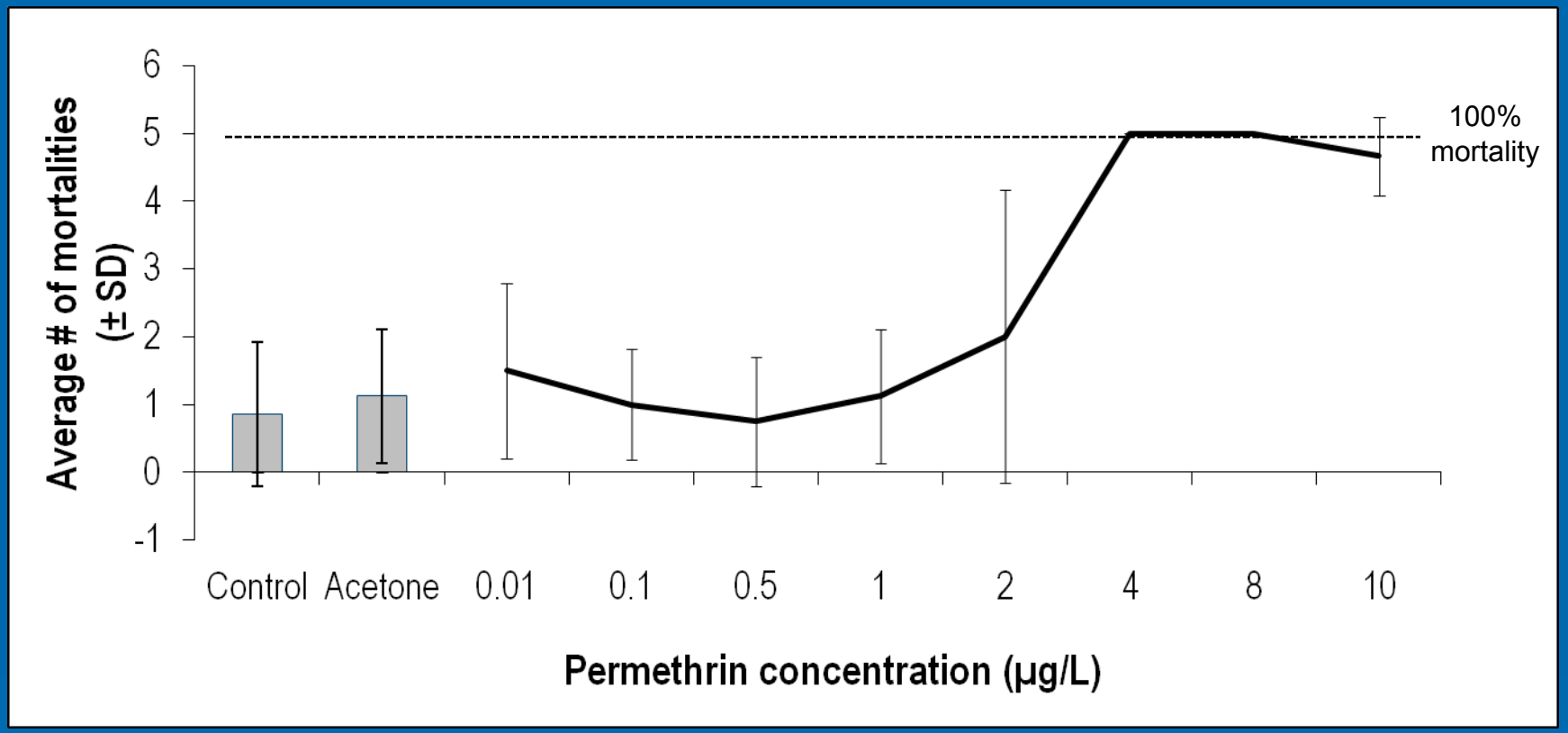
FWRI Lobster Larval Exposure Tests

Pesticide	Start Date	End Date	# Larvae
Permethrin	10/19/2012	10/31/2012	151
Permethrin	2/19/2013	3/1/2013	175
Malathion*	11/17/2012	12/14/2012	150
Malathion*	3/19/2013	3/27/2013	172
Naled	1/16/2013	2/1/2013	150
Naled	5/16/2013	5/24/2013	61

* inconclusive

Lobster Toxicity Testing

Permethrin lobster larvae mortality

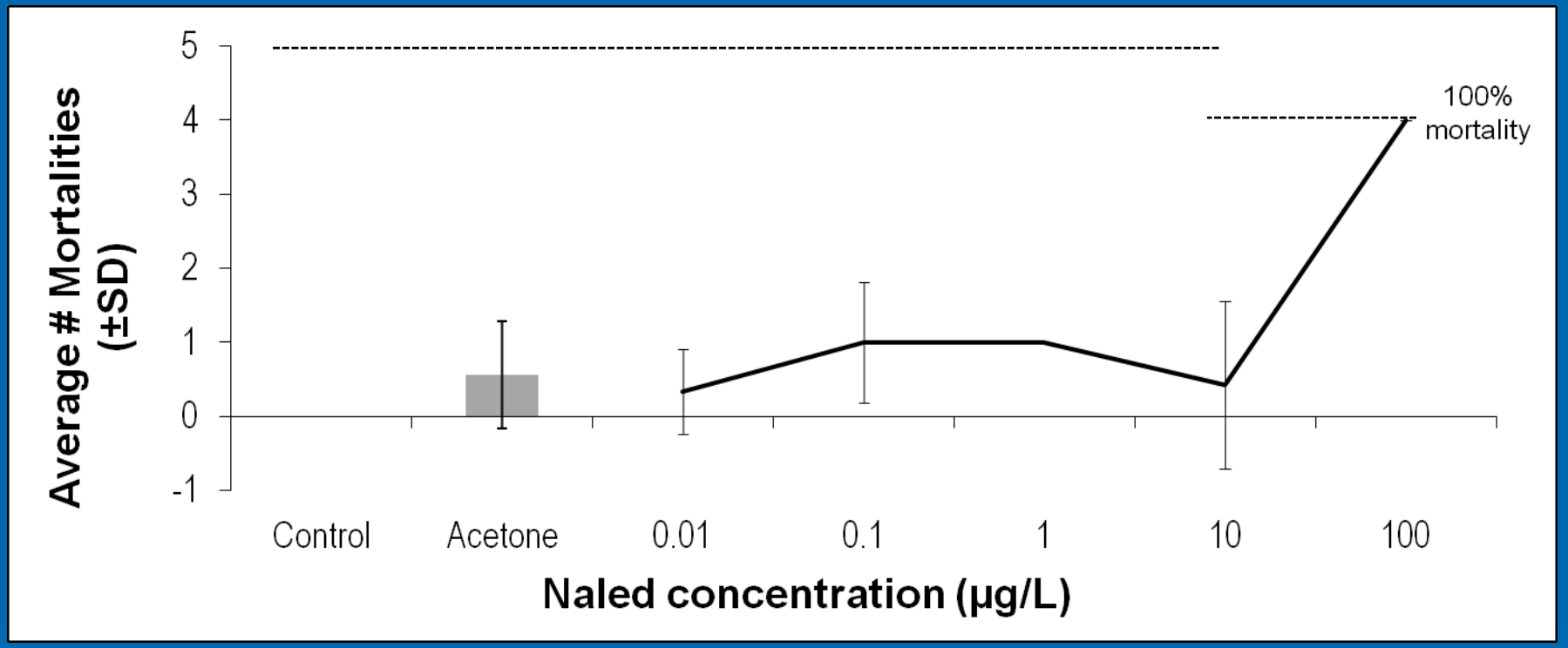


- Mortality above control observed at >2 to 10 µg/L
  - 5-10 µg/m^2 observed in field (Pierce et al 2005)

- Mortality:
  - Control- Trial 1: ~30%, Trial 2: ~5%
  - Acetone- Trial 1: ~37%, Trial 2: ~15%
  - Acetone reduced from 20µg/500mL to 2 µg/500mL

Lobster Toxicity Testing

Naled lobster larvae mortality



- 100% mortality at 100µg/L
  - 0.1-.6 µg/L observed in field (Pierce et al 2005)

- Acetone related mortality
  - Trial 1: ~13% mortality, Trial 2: ~10% mortality
  - Acetone reduced from 20µg/500mL to 2 µg/500mL
- Need to determine LC-50 between 10 & 100µg/L

Coral Larvae Toxicity Tests

K. Ritchie, E. Hall, & R. Pierce; Mote Tropical Research Lab, Summerland Key, FL

Larvae of the scleractinian coral (*Porites astreoides*) exposed to environmentally relevant pesticide concentrations.

Toxicity end points include:

- Acute toxicity: LC-50, 96 hr.
- Sub-lethal toxicity: larval metamorphosis from planula to primary polyp

Planula **Primary Polyp** **Adult Polyp**

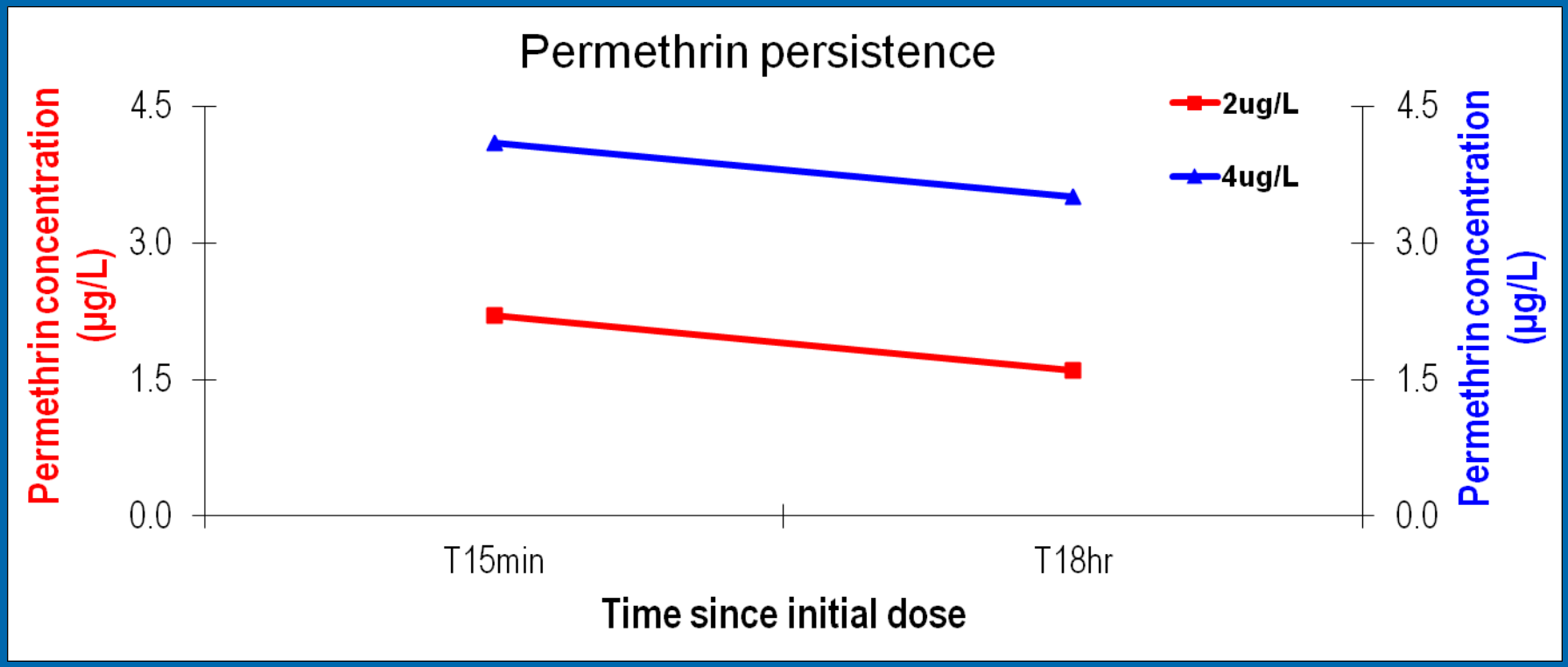
Coral Exposure Tests

Date	Pesticides
4/10-12/2013	Permethrin, Naled
5/9-10/2013	Permethrin, Naled
5/15/2013	Permethrin, Naled
6/8/2013	Naled

Larvae collection

Larval Dosing

Coral Larvae Exposure to Permethrin



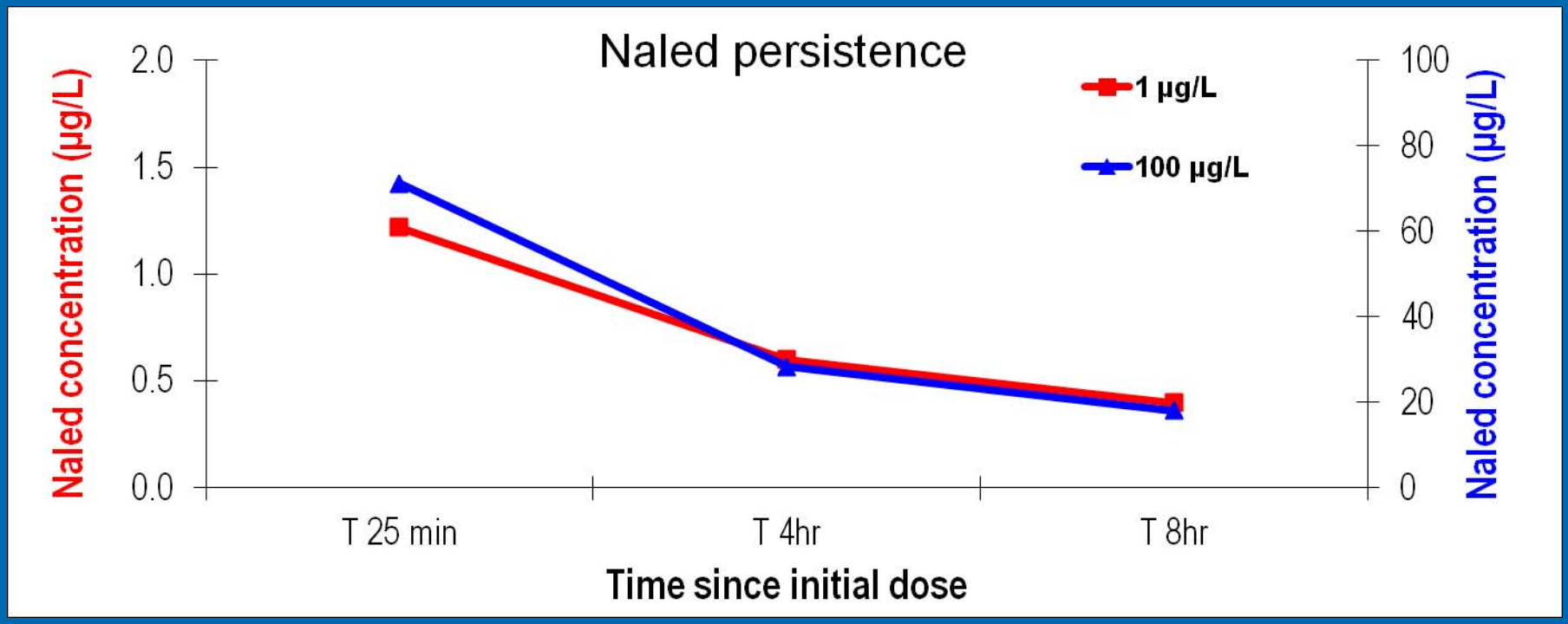
Permethrin persistence:

- Little degradation over 18 hrs

Coral larvae exposures:

- No acute toxicity up to 10 ug/L
- Higher exposure concentrations and sub-lethal effects exposure tests are under investigation

Coral Larvae Exposure to Naled



Naled Persistence:

- Naled rapidly degrades in water (half-life ~ 6 hours)

Coral larvae exposures:

- No acute toxicity up to 10µg/L
- 100% mortality at 100µg/L
- Sub-lethal impacts under investigation

Field Monitoring Protocol

Monitoring sites:

1. Snake Creek -Venetian Shores canals, Islamorada
2. Key Largo canals and adjacent Atlantic Ocean

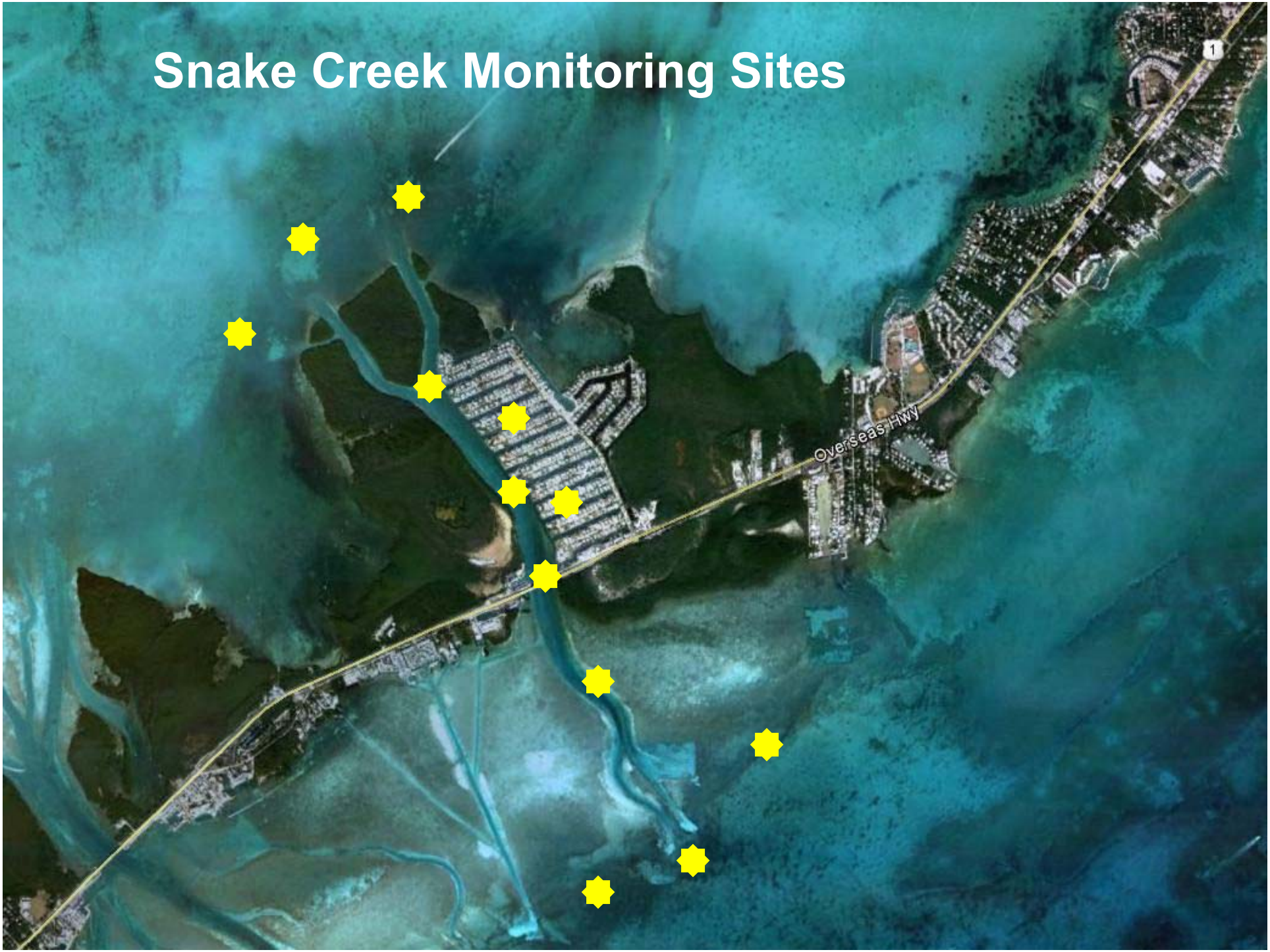
Each site monitored twice

Sample collection:

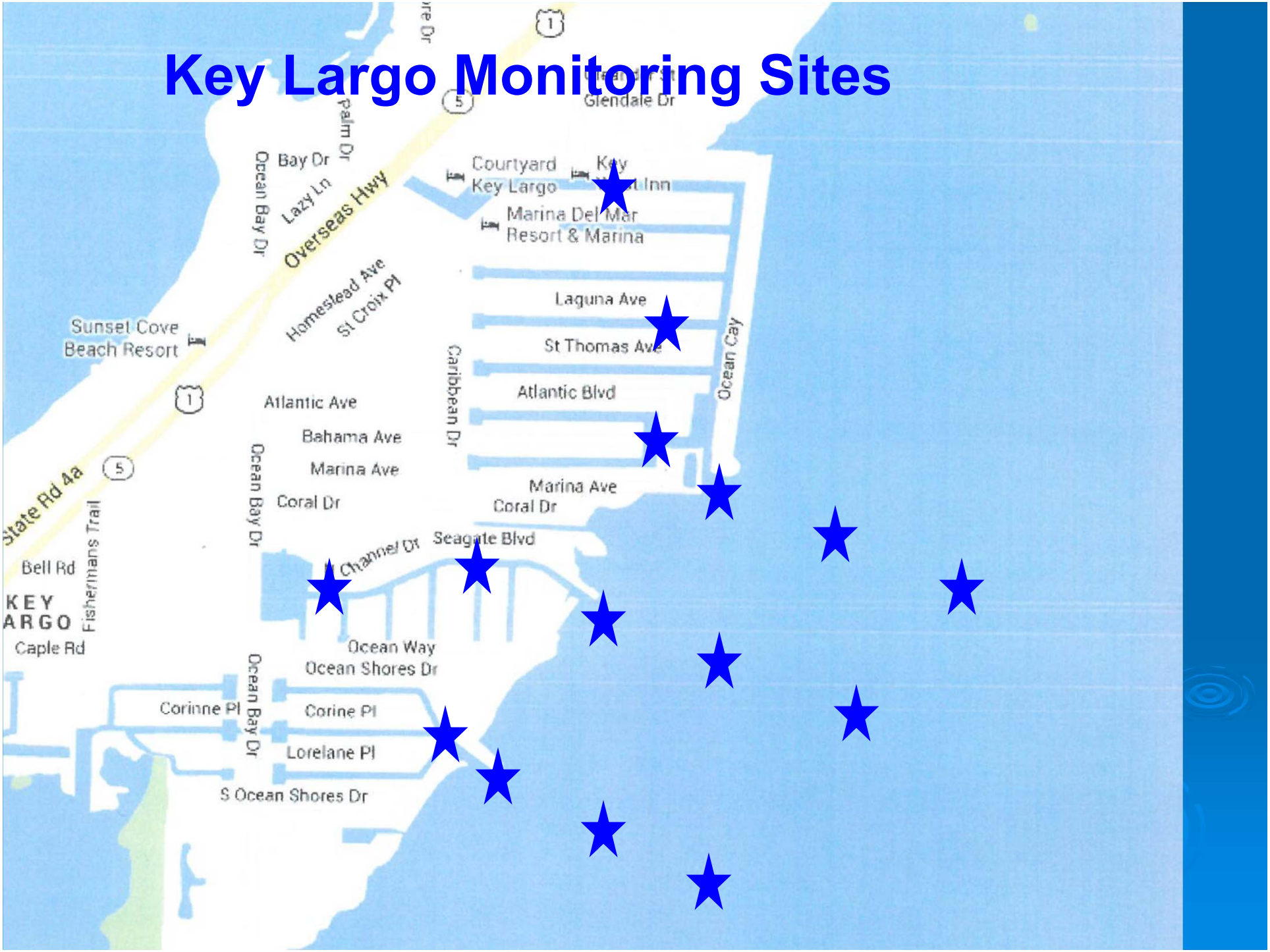
Pre-application 12 or 15 sites

- 2 to 3 hrs post application (All pesticides)
- 6 to 8 hrs post application (Naled only)
- 12 to 16 hrs post application (Permethrin & Malathion)

Snake Creek Monitoring Sites



Key Largo Monitoring Sites



Future Studies
Summer and Year 2:

1. Monitor field applications to determine environmental exposure concentrations, distribution and persistence

2. Identify residential pesticide misting systems

3. Complete toxicity tests for acute toxicity and sub-lethal impacts