

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

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Mote Marine Laboratory, Ecotoxicology

Project manager, field monitoring, pesticide analysis

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Mote TRL, Marine Microbiology

Coral larvae toxicity studies

Thomas Matthews, Co-PI,

FL Fish & Wildlife Research Institute

Lobster larvae toxicity studies & Field Sampling

Project-Specific Goals

1. To determine if applications of mosquito control pesticides in the FL Keys result in toxic effects to NMS organisms.
2. Work with stakeholders to assess the risk and develop appropriate response strategies as needed to maintain mosquito control while reducing the risk to the NMS.



- **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



Coral larvae:
Porities asteorites,



Spiny Lobster ,Puerulus

Application of Results

Results will provide FL Keys NMS Resource Managers and FL Keys Mosquito Control District Managers with empirical data to:

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



Unique Public-Private Partnership

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



Shared Project Support

<u>Funding/Collaborators:</u>	<u>Year-1</u>	<u>Year-2</u>
US EPA WQPP, FL Keys NMS;	\$70,000	\$30,000 (\$100,000 max)
FL Keys Mosquito Control Dist.;	\$25,000	\$25,000 (pending)
<u>Levi Research Fund (Mote);</u>	<u>\$25,000</u>	<u>\$25,000</u>
Project Budget	\$120,000	\$80,000 (\$200,000/ 2 yrs)

In-Kind Support

NOAA-National Marine Sanctuary; In-Kind Support (field & results)

FL FWRI field & lobster toxicity; In-Kind Support (\$33,670)

Mote, Field monit. & Coral toxicity; In-kind Support (~\$33,000)

Additional funds sought to: a) expand monitoring residential pesticide use, b) provide additional field monitoring of pesticide applications, and c) test synergistic effects of multiple pesticide exposures.

<u>Year-1</u>	<u>Year-2</u>
\$25,000	\$30,000

Background: Previous EPA WQPP/FKMCD Study Key Largo 1998

- **June 16-18, and July 28-29, 1998**
 - **Evening ground ULV Permanone**
 - **Morning Aerial ULV Dibrom**

- **September 22-23, 1998**
 - **Evening ground ULV Permanone**
 - **Morning: no Dibrom, Hurricane Georges Evacuation**

Pesticide Monitoring Stations:

B = Bay Side

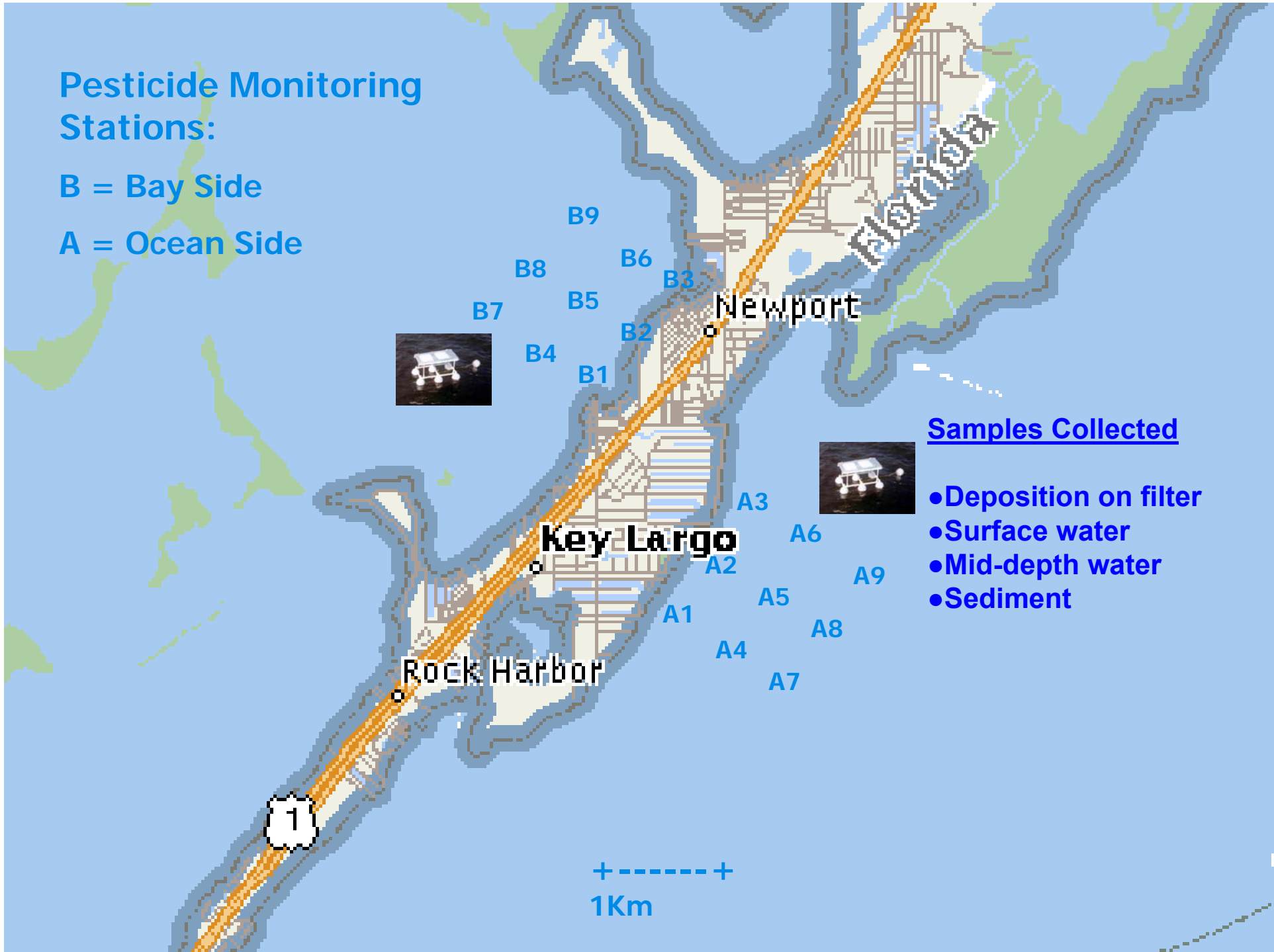
A = Ocean Side



Samples Collected

- Deposition on filter
- Surface water
- Mid-depth water
- Sediment

+-----+
1Km



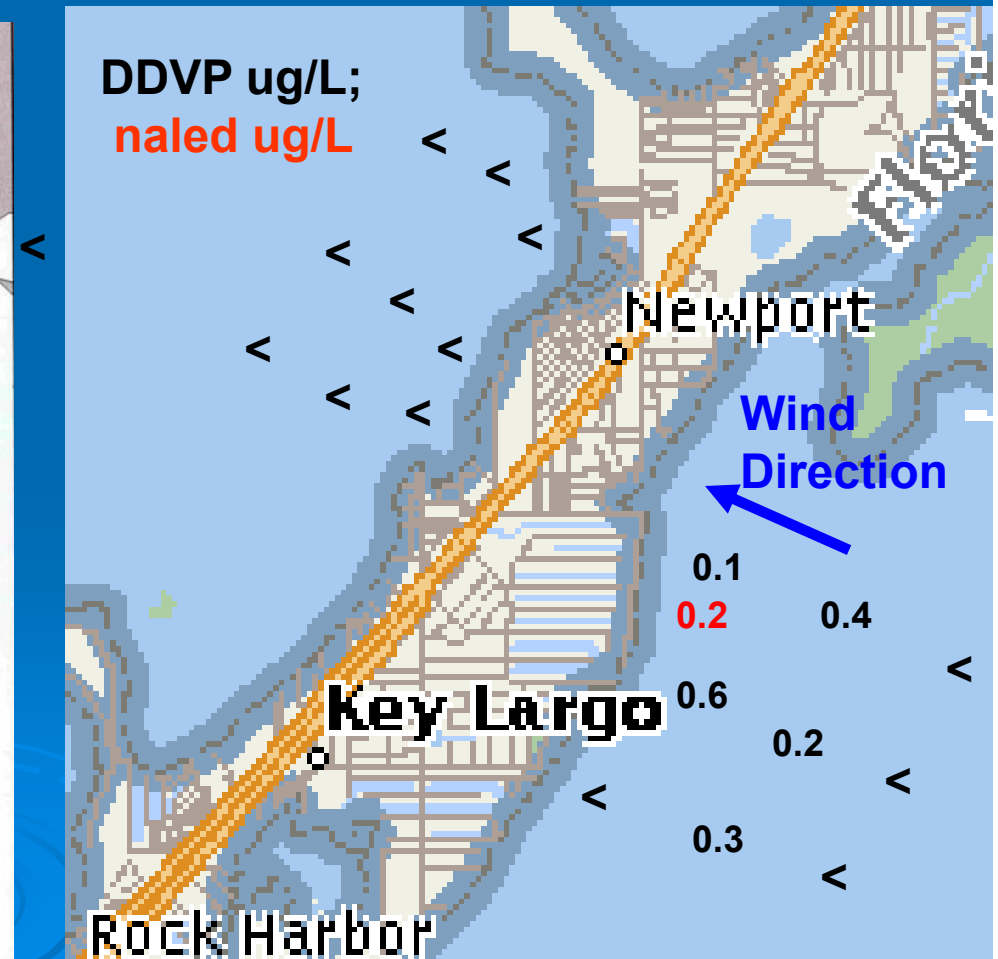
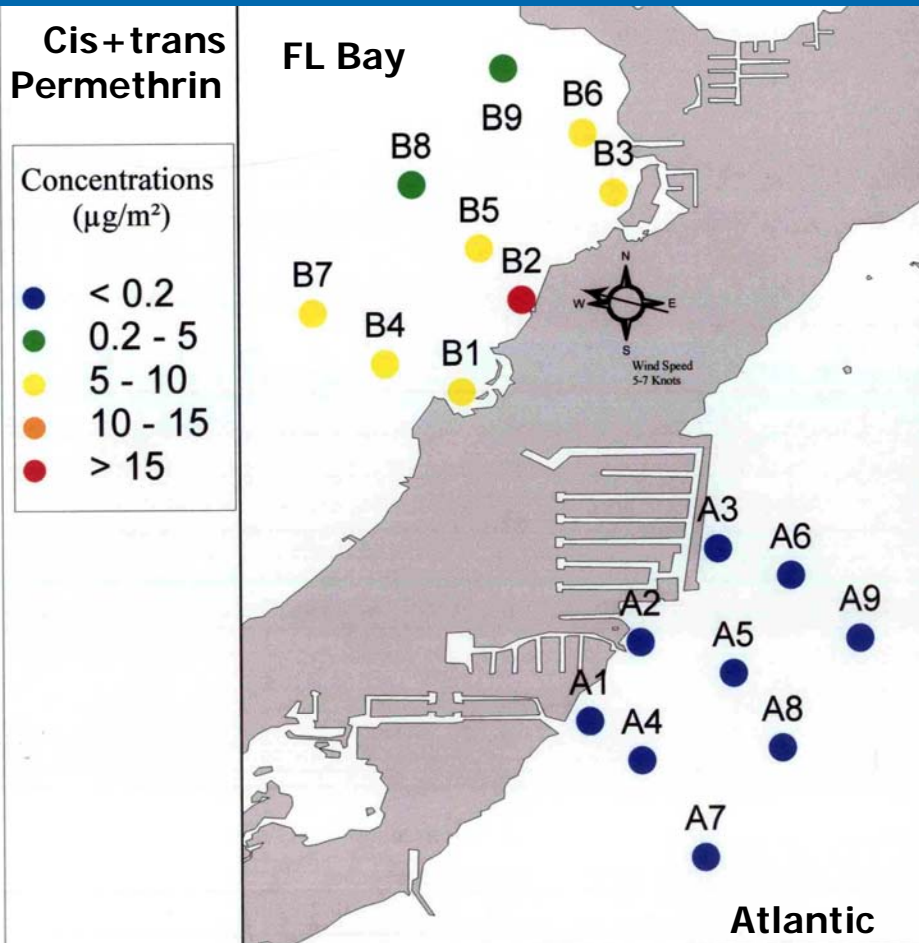


June 16, Permethrin, evening
 June 17, naled, morning



Permethrin: Drift Deposition of on Filter Pads @ 2-4 hours after application None detected in water

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



Permethrin Application Evening, September 22, 1998

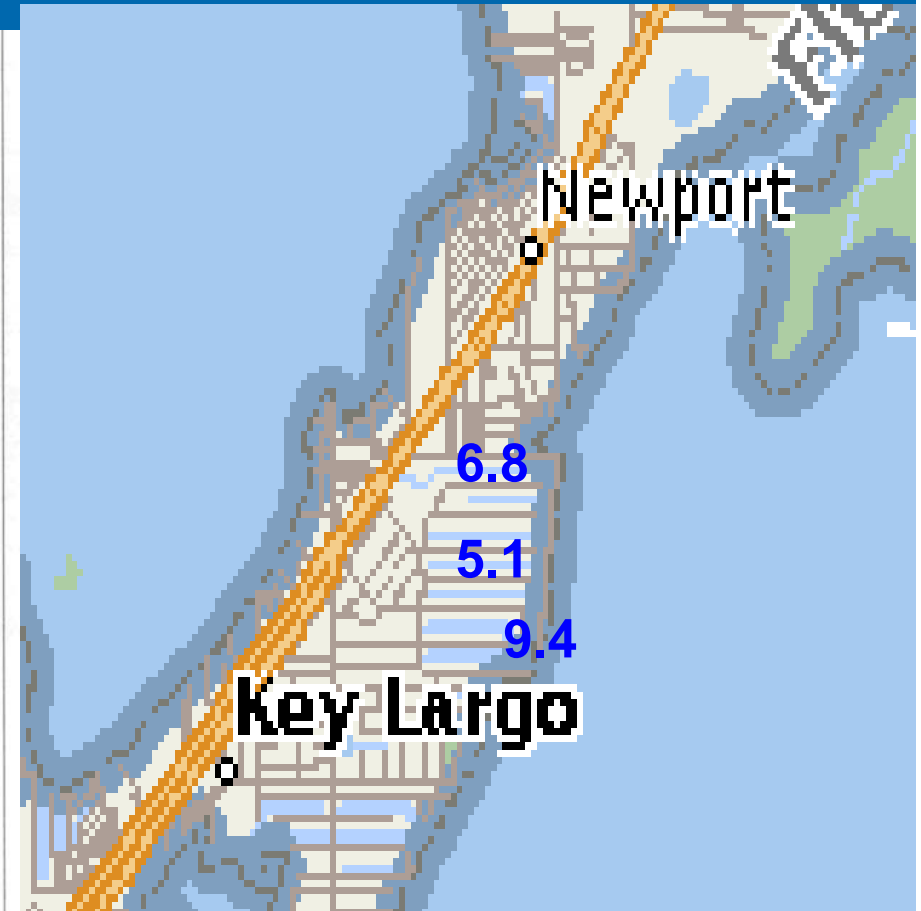
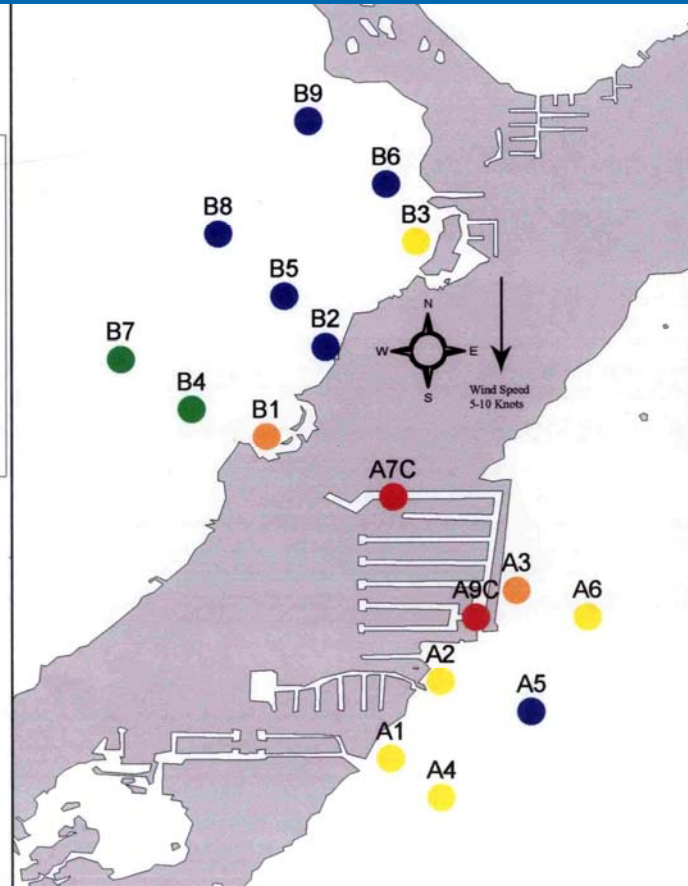
Deposition of Permethrin on filter pads, 2-4 hours after application
- Added Canal Samples

Permethrin ug/L In Canal
Surface Water

Cis+trans
Permethrin

Concentrations
($\mu\text{g}/\text{m}^2$)

- < 0.2
- 0.2 - 5
- 5 - 10
- 10 - 15
- > 15



Acute Toxicity (96 hr LC-50) of Permethrin, Dibrom, DDVP and Malathion to *Mysidopsis bahia*, and *Penaeus duorarum*. Persistence (1/2 life) and solubility in seawater.

<u>Pesticide</u>	<u>96 hr LC-50</u>	<u>ug/L (ppb)</u>	<u>Half Life</u>	<u>Solubility</u>
<u><i>M. bahia</i></u>	<u><i>P. duorarum</i></u>	<u>days</u>	<u>mg/L (ppm)</u>	
Permethrin	.02-0.1	0.2	1-3	.006
<i>Note: tech. ~ 1/3 cis, 2/3 trans; toxicity cis >>> trans) + PBO</i>				
Dibrom	4.7-8.8	1.8	< 1	2,000
DDVP	19	-	< 1	-
Malathion	2.2	280	2-4	130

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

CONCLUSIONS

Permethrin (cis+trans):

Observed on filters, leeward side of Keys => Aerial drift into NMS

No Acutely Hazardous concentrations observed in off-shore water

Hazardous concentrations indicated for permethrin in canal water.

Need toxicity studies with technical product to verify hazard

Dibrom/DDVP:

None detected on filters or surface water

Low concentrations detected in mid-depth water out from canal systems, indicates tidal transport from canals.

No Acutely Hazardous concentrations were detected in surface or mid-depth water

Canal monitoring cancelled due to hurricane Georges

Questions that need to be Addressed

Do pesticides remain/degrade in canals, or are they transported out into the NMS?

If pesticides are transported by aerial drift and/or tidal transport to the NMS, are they in significant concentrations to cause lethal and sublethal effects (development, reproduction)?

What is the contribution of residential pesticide applications to pesticide loading in the NMS?

If toxicity is indicated, what application strategies can be implemented to maintain adequate mosquito control while reducing the risk to marine organisms?

The New Mote EPA-WQPP FL Keys NMS Study Objectives 2012 to 2014

Monitor ground and aerial applications of mosquito adulticides (labeled, permethrin and malathion), to assess transport, distribution, concentration and persistence in NMS.

Measure the toxic effects of environmental concentrations of the pesticides to early life stages of coral and Spiny lobster through critical stages of metamorphosis that occur in near-shore NMS.

Assess the contribution of residential pesticide applications to pesticide input to near-shore NMS habitat.

Work with EPA, NMS, FL FWRI and the FKMCD to evaluate potential impacts and develop appropriate response strategies, as needed.

Field Monitoring Protocol

Monitor pesticide concentrations in water samples from two possible sites, two applications each pesticide

1. Snake Creek @ Windley / Plantation Key

2. Key Largo (as above)

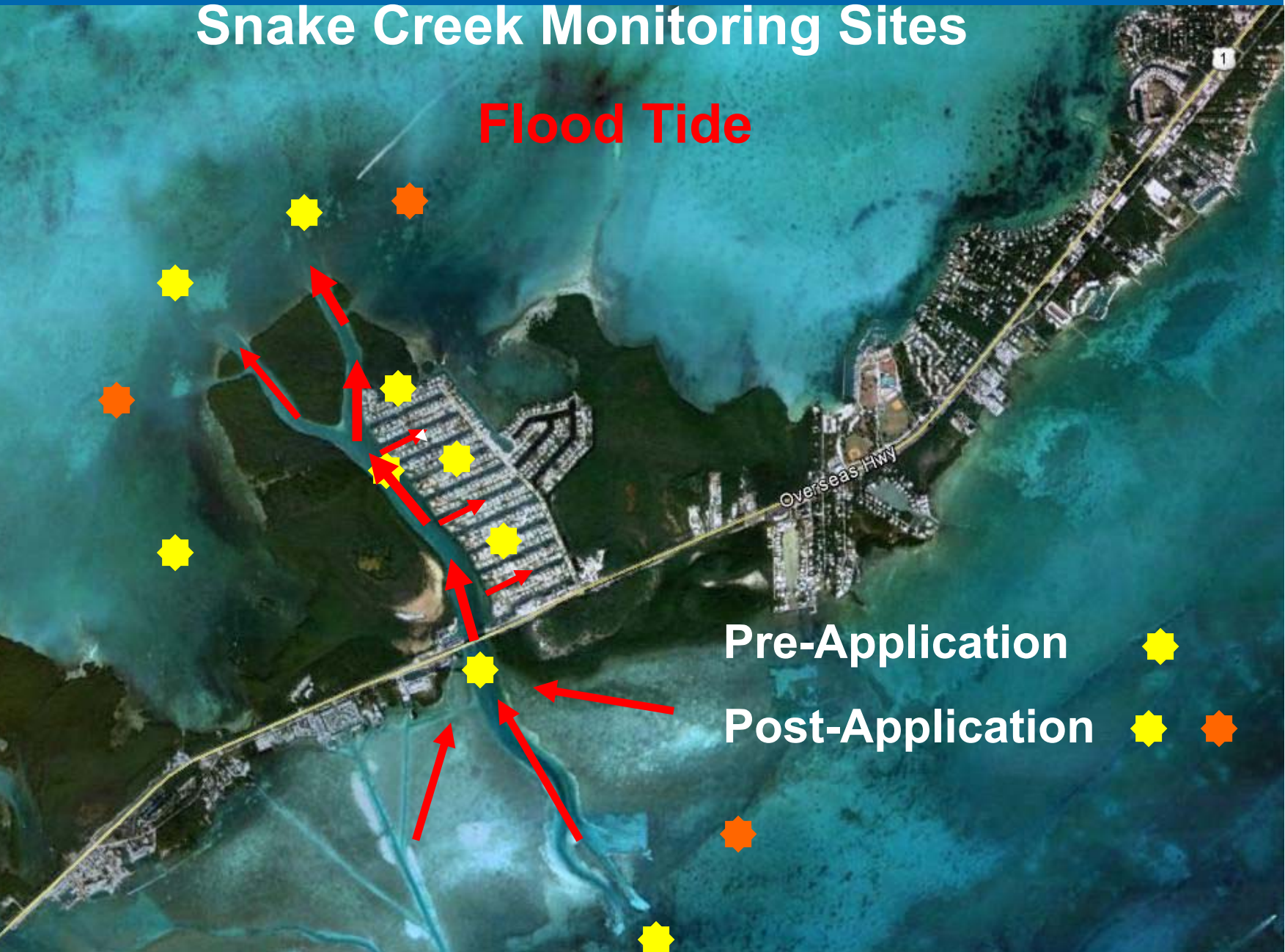
- Pre-application 9 to 12 sites
- 2 to 3 hrs post application (All pesticides)
- 6 to 8 hrs post application (naled only)
- 12 to 18 hrs post application (Permethrin & Malathion)

**Water sample collections by:
FL FWRI, NOAA-NMS & Mote**

Pesticide analysis by: Mote

Snake Creek Monitoring Sites

Flood Tide

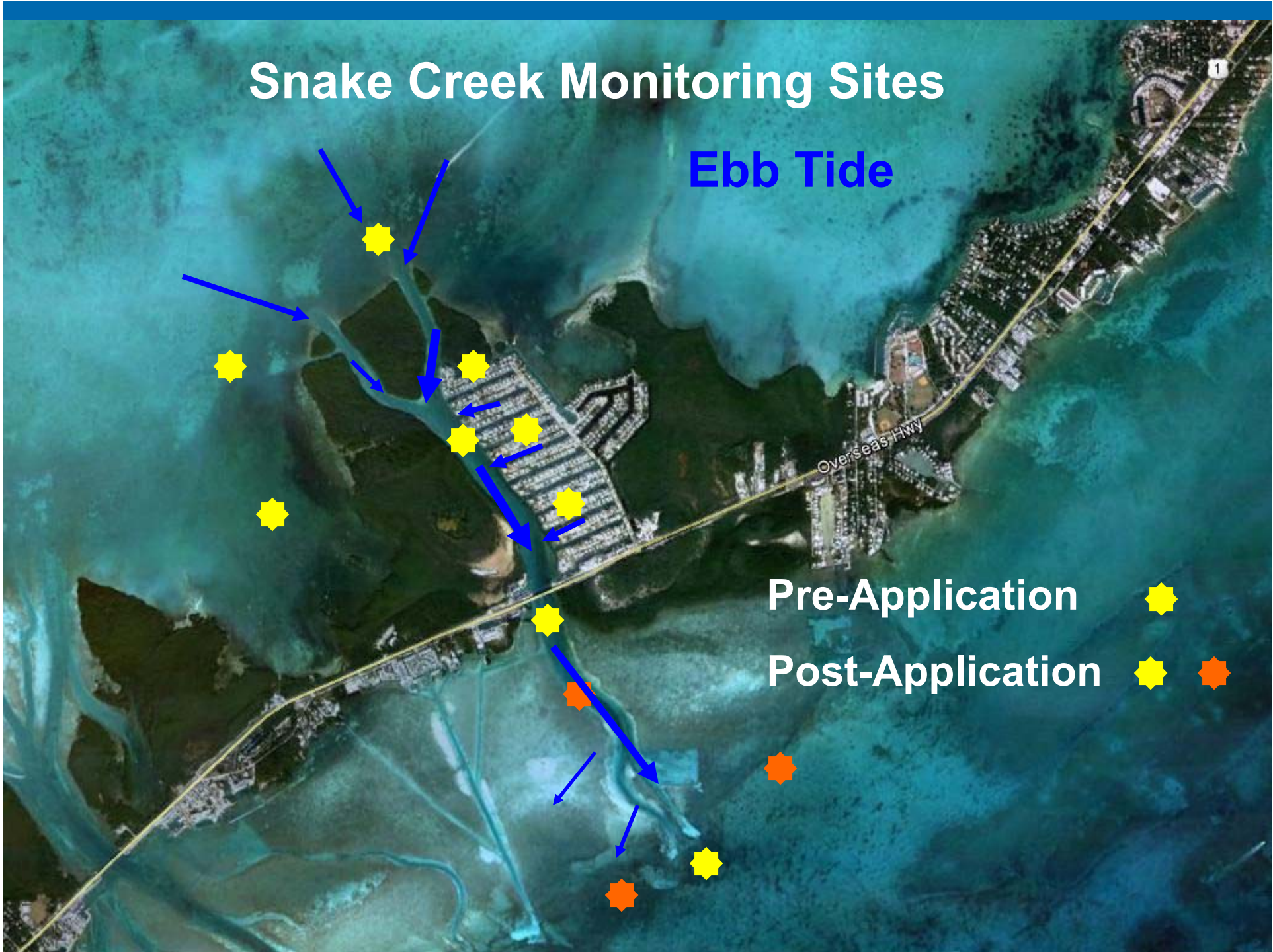


Pre-Application 

Post-Application  

Snake Creek Monitoring Sites

Ebb Tide



Coral Larvae Toxicity Tests

Kim Ritchie and Emily Hall; Mote Tropical Research Lab,
Summerland Key, FL

Larvae of the scleractinian coral (*P. astreoides*) will be exposed to environmentally relevant concentrations of the technical formulations of each pesticide. Toxicity end points will include:

- Acute toxicity; LC-50, 96 hr.
- Sublethal toxicity; Larval metamorphosis from planula to primary polyp (primary septa) development.



Planula



Primary Polyp



Adult Polyp

Lobster Larvae Toxicity Tests:

Tom Matthews & Gabe Delgado with other FWRI staff

Spiny lobster (*Panulirus argus*) will be exposed to environmentally relevant concentrations of technical formulations of each pesticide. Toxicity end points will include:

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



Phyllosome Larvae



Puerulus Post Larva



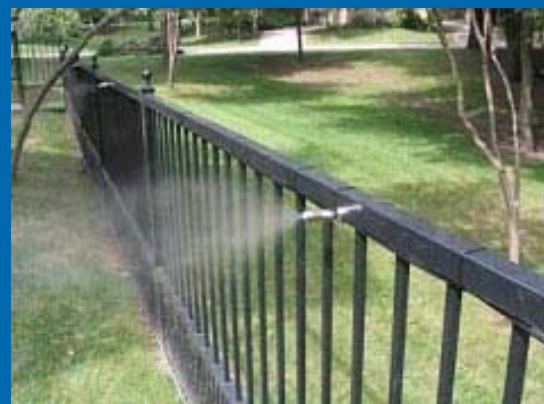
Adult Spiny Lobster

National Geographic photos

Residential Pesticide applications

Monitor Drift and runoff from:

- **Pesticide misting systems:
(This Study)**



- **Lawn maintenance:
(Future Study)**



Common Goal for All Stakeholders:

- preserve and enhance the living resources of the National Marine Sanctuary
- while maintaining adequate mosquito control to protect the public health and economic well being of the FL Keys.

