Design Objectives

Create a drifter fleet designed around common backpacking GPS units

Desired Traits:
- Shallow deployments
- No specialized tools
- No specialized training
- Relatively inexpensive
- Adaptable
- Simple and easily recreated

A) Behnam and Gholan 2010 B) Johnson et al 2003
C) Lee et al 2011 D) http://gisweb.whoi.edu/ioos/drift/driftdesign.html
Drifter Construction: Capsule

- A drifter fleet was constructed out of 4 inch diameter PVC pipe, fitted with a rounded end cap and threaded top and top cap
  - materials were obtained from local hardware stores
  - PVC fittings were joined using PVC primer and PVC glue to prevent leaking into the capsule interior
    - Drifter #1 drifted out of PKS canal into Hoop Pole Creek, adrift for 3 weeks, and the capsule interior was dry when returned to UNC-IMS
- Drifters were painted fluorescent orange to aid in relocation after deployment
Drifter Construction: Drogues

- Designed after surf drogue (Johnson et al 2003)
  - larger but same proportions (8 x 14")
- Intended to prevent capsule from surfing
- Sewn with 18oz VCP truck tarp and heavy tubular nylon
GPS Devices and Calibration

- RINO 610 and 520 GPS devices
- GPS devices recorded position of the drifter in 3 second intervals
- Drifter location could be polled using additional GPS units ("Master" Units) on the boat
  - Polling was limited by line of sight (radio-wave polling system) and frequency
  - GPS devices were held above the surface of the water to insure signal transmission
- Drifters did not have the capability to relay stored data back to master GPS units
Final Product:

- Waterproof Cap
- Approximate Water Level
- Removable Nylon Harness (with D-ring attachment)
- Fishing Twine Tether
- Drogue
Drifter Fleet Analysis and Optimization

Testing a drifter fleet and drogue adaptations for different environments

Dr. Rossman Lab 2012
Drifters as tools

- Data provided is lagrangian and therefore specific to free floating instruments
  - Scientifically invaluable for spill mapping, pollutant/larval dispersal, topographical flow variation, Gulf Stream mapping
- Drifter use for circulation mapping dates back 400 years (Richardson 2001)
- Until 2000 purposeful SA made non-military GPS use difficult (Behnam & Gholam 2010)
- Only recently have handheld GPS units gained the accuracy to be scientifically useful on a small scale

NOAA/AOML Global Drifter Program
http://www.aoml.noaa.gov/phod/dac/dac_animations.php
http://www.aoml.noaa.gov/phod/dhos/lcs.php#LCS
Accurate Lagrangian drifters

- Wind slip and wave interference
  - Oceanic drifters are primary focus of research and design
- Davis 1985 and C.O.D.E. design
  - Decoupled surface portion and drogue
  - Created larger submerged cross-section
- The drag area ratio quantifies the potential for wind slip

\[
DAR = \frac{\sum A_{\text{drogue}} \cdot C_{\text{drogue}}}{\sum A_{\text{other}} \cdot C_{\text{other}}}
\]

- Commercial drifters have standardized a DAR of 40 (40:1) to avoid problems when combining datasets
Our Drifters and DAR

- Designed for PKS canal
  - No waves
  - Little wind

<table>
<thead>
<tr>
<th>Drogue</th>
<th>DAR</th>
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</thead>
<tbody>
<tr>
<td>None</td>
<td>2</td>
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<tr>
<td>Cone</td>
<td>7.1</td>
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<tr>
<td>Commercial Standard</td>
<td>40</td>
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</tbody>
</table>

- Several recent papers included un-drogued drifters while others used the large X-shaped or “Davis” drifter (Lee et al 2011, Perez et al 2003)
Construction of Davis drifter drogue

- Designed to attach to existing drogue
- Can be lowered to different depth
- Can be broken down for transport
- Designed to achieve drag ratio of exactly 40
- Final DAR = 40.6
Comparison of drogues for protected water bodies

Setup:
Run different drifter types over stationary current profiler and compare recorded velocities

Drifter types:
I. No drogue
II. Shallow Cone
III. Deep Cone
IV. Davis

For drag coefficient comparison with same frontal area
Results

• 1x1 plots

0 5 10 15 20 25
16:48 16:50 16:53 16:56 16:59
No Drogue

5 10 15 20 25
16:13 16:16 16:19 16:22 16:24
Short Cone

10 15 20 25 30
16:27 16:30 16:33 16:36 16:39
Long Cone

10 12 14 16
10:33 10:40 10:48 10:55 11:02
Davis

Velocity (cm/s)

10:33 10:40 10:48 10:55 11:02
11:09 11:16 11:24
11:16 11:24

Velocity (cm/s)
### Results

- Average drifter velocity indicates accuracy
- Spread indicative of precision
  - RMS error includes directional bias

<table>
<thead>
<tr>
<th>Drifter Type</th>
<th>Profiler Velocity (cm/s)</th>
<th>Drifter Avg Velocity (cm/s)</th>
<th>Velocity difference (cm/s)</th>
<th>RMS error (cm/s)</th>
<th>Spread (cm/s)</th>
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<tbody>
<tr>
<td>No Drogue</td>
<td>19.93</td>
<td>10.84</td>
<td>9.09</td>
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<td>Davis</td>
<td>8.77</td>
<td>8.21</td>
<td>0.56</td>
<td>1.96731585</td>
<td>1.89</td>
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Conclusions

• Cone drogue is likely acceptable for protected waters
  o Less bulky
  o Less expensive

• Davis may excel on longer deployments

• **Must** have some type of sub-surface drogue
  o Cannot get away with floating box

• Data transmission via satellite is nice but...
  o Commercial system not necessary or effective
  o Less drifters in the water due to cost
Special Thanks:

• Dr. Johanna Rosman
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• Steve Fegley
• Chris Cook
• Rachel Housego
Questions...
Handheld GPS units for measuring velocity

Drifters moved with truck at constant speed, gave following profiles
Highest error with lower velocity

Sabet, Barani