Shallow Marine Monitoring

No single monitoring technique is sufficient:

**Passive acoustics:** Listening for bubbles
- Low power, relatively small range
- Good for detection and quantification
- Baselines: Shelf seas are acoustically complex

**Active acoustics:** Detecting gas plumes in sediments and water with sonar
- Power hungry, larger range (>100m)
- For detection
- Baselines: Requires characterisation of area for natural seeps / deposits

**Geochemistry:** Sensors for pH and pCO₂, isotopes and tracers
- Low power, range dependent on leak rate
- For detection, confirmation, quantification
- Baseline: Requires detailed characterisation of local baseline

**Biological indicators:** Video + software analysis or direct sampling
- Power hungry, need to be close
- Possibly detection, mainly impact assessment
- Baseline: Requires detailed baseline and control

Trade off between detection range / survey resolution / power consumption / deployment time / areal coverage
1. Detect anomalies:
   - Wide area surveys on AUVs / Site specific landers near “high-risk” sites
   - pH / pCO₂ / passive acoustics / active acoustics
2. Confirmation and attribution:
   - Targeted sampling
   - CO₂ assays, isotopic composition, tracers
3. Quantify leakage:
   - Targeted sampling
   - Passive acoustics, benthic chambers, reverse modelling
4. Assess impact:
   - Targeted sampling
   - Biological and biochemical surveys

### Good baselines are vital: reduce false +/-ves, economic monitoring

**Economic Baseline strategy**

<table>
<thead>
<tr>
<th>Sampling frequency</th>
<th>Duration</th>
<th>What</th>
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<tbody>
<tr>
<td>Hourly</td>
<td>Few days during main growing season</td>
<td>Carbonate chemistry</td>
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<td></td>
<td></td>
<td>Oxygen, Temperature</td>
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<td></td>
<td></td>
<td>Pressure, Salinity</td>
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<tr>
<td>Weekly</td>
<td>During main growing season preferably whole year</td>
<td>Carbonate chemistry</td>
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<tr>
<td></td>
<td></td>
<td>Oxygen, Temperature</td>
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<td></td>
<td></td>
<td>Pressure, Salinity</td>
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<tr>
<td>Monthly</td>
<td>18 month period encompassing two summers</td>
<td>Acoustics</td>
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<tr>
<td></td>
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<td>Biological coring</td>
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<tr>
<td>Occasionally</td>
<td>One or two surveys with a repeat after a few years</td>
<td>Geophysics</td>
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<tr>
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<td>Imaging</td>
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Requires repeat on ~decadal scale
a) **Autonomous underway vehicles:**
Occasional monitoring of storage complex footprint, 1-3 month deployment.

b) **Benthic landers:** For specific at risk locations
Semi-permanent but vulnerable to trawling

c) **Data retrieval:** via surface platforms