Understanding and preventing accidents in led outdoor activities: theory, methods, and UPLOADS

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Content

• Action items
• Background
• Accident causation models
• Accident analysis methods
• UPLOADS
• Next steps
• Take home messages
Action items

1. Review your organizations accident and near miss reporting and analysis systems and question whether appropriate data is currently being collected and analysed in-line with contemporary accident causation models;

2. Re-analyse a sub-set of incidents using the systems analysis framework presented. Use the outputs to communicate the systems analysis philosophy throughout your organization;

3. Consider, with others in your organization, the benefits of contributing data to an International accident and near miss database such as UPLOADS.
Background - Expertise

- Development and management of accident and incident surveillance systems e.g. ANCIS, AVSAFE, VISU
- Human Factors
- Accident Causation and analysis
Background

- Accidents & Injury during led outdoor activities

  • Acknowledged risk of severe and frequent injury in active pursuits (Finch et al, 2007)

  • Accidents & injury problematic in led outdoor industry domain

  • Industries understanding of accidents & injury limited

  • Systems required to enhance understanding do not exist
What can we do about it?

- Appropriate study of accidents an accepted approach for enhancing safety
- Accident and injury surveillance systems/Databases
- Theories and methods used to understand accidents critical
- Application of contemporary theories and methods e.g. Systems approach to accident causation
- Collective mindfulness required
Accident causation

- Person approach out-dated

- Accidents as systemic, emergent phenomena

- “Safety is impacted by the decisions of all actors – politicians, CEOs, managers, safety officers and work planners – not just the front-line workers alone” (Cassano-Piche et al, 2009)
The systems approach

- Complex, systems phenomenon
- Contributing factors reside at different levels of the ‘system’
- Factors interact with one another within and across levels of the work system
- Normal, routine behaviours at one level shape performance at another
- Will continue to occur within safety critical systems
Rasmussen’s risk management framework

- Real, invisible, safety boundary
- Economic failure boundary
- Unacceptable workload boundary

Adverse events:
- Government
- Laws
- Regulators, Associations
- Regulations
- Company
- Regulations
- Company Policy
- Management
- Staff
- Plans
- Work
- Hazardous process

Public opinion
- Changing political climate and public awareness
- Government
- Regulators, Associations
- Company
- Laws
- Regulations
- Company Policy
- Management
- Staff
- Plans
- Work
- Hazardous process

Fast pace of technological change
- Boundary defined by official work practices
- Changing market conditions and financial pressure
- Changing competency levels and education

Changing political climate and public awareness
Accident causation predictions (Rasmussen, 1997)

• Safety is an emergent property impacted by decisions of all actors, not just front line workers alone
• Threats to safety are caused by multiple contributing factors, not just a single catastrophic decision or action
• Threats to safety can result from a lack of vertical integration across levels of a complex sociotechnical system, not just from deficiencies at one level alone
• Lack of vertical integration is caused, in part, by lack of feedback across levels of a complex sociotechnical system
• Work practices are not static, they migrate over time and under the influence of financial and psychological pressures
• Migration occurs at multiple levels of complex sociotechnical systems
• Migration of work practices cause system defences to degrade and erode gradually over time, not all at once. Accidents are caused by a combination of this migration and a triggering event(s)
Herald of Free Enterprise Zeebrugge disaster

- Ferry capsized
- 150 passengers & 38 crew killed
- Ferry set sail with inner bow doors open
Systems failure

- Inherent unsafe ‘top heavy’ ferry design
- Pressure to depart early
- Failure to install bow Door indicator
- ‘Not my job’ Culture
- Negative reporting culture
- Poor rostering
- Fatigue
- Assistant bosuns failure to shut bow doors
- Captains leaves port with bow Doors open
- Choppy sea
Accident analysis

“Complex systems cannot be understood by studying parts in isolation. The very essence of the system lies in the interactions between parts and the overall behaviour that emerges from the interactions. The system must be analysed as a whole” (Ottino, 2003)
Systems-based accident analysis

• Hunt for the broken component mentality flawed (e.g. Dekker, 2011)

• Need to go ‘Up & Out’ rather than ‘down & in’

• Systems-driven countermeasures/interventions more appropriate than individual component driven ones (Dekker, 2002; Reason, 1997)
Fixing components vs System reform

Stay or go policy fails to cover fire severity
Lack of community education
Comms failures
Inadequate warnings
Failure of fire crews to evacuate residents
Police warning siren issued late
Fire plan failures
Delayed evacuation
Accimap example: Mangatepopo Gorge

- 15th April 2008, Mangatepopo gorge, Tongariro National Park
- Gorge walking activity
- Six students and their teacher drowned
- Various contributory factors identified (Brookes et al, 2009)
Multiple people involved in creating system in which accident occurred

Causal factors present across all levels of activity 'system'

Accimap description based on Brookes et al (2009)
A systems approach in the outdoors?

- Rasmussen’s framework applicable (Salmon et al, 2010)
- Accimap most suitable systems-based accident analysis method for use in led outdoor activity domain (Salmon et al, 2012)
- Recent case study and multiple case analyses
- Use of systems approach likely to increase understanding of injury incident causation and enhance success of interventions
### Outputs?

<table>
<thead>
<tr>
<th>Organisational Influences</th>
<th>Organisational process (65%)</th>
<th>Organisational climate (29%)</th>
<th>Resource management (29%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unsafe supervision</strong></td>
<td>Supervisory violation (4%)</td>
<td>Planned inadequate operations (33%)</td>
<td>Inadequate supervision (22%)</td>
</tr>
<tr>
<td><strong>Preconditions for unsafe acts</strong></td>
<td>Technological environment (33%)</td>
<td>Physical environment (56%)</td>
<td>Crew resource management (15%)</td>
</tr>
<tr>
<td><strong>Unsafe acts</strong></td>
<td>Violations (57%)</td>
<td>Skill-based errors (64%)</td>
<td>Decision errors (34%)</td>
</tr>
</tbody>
</table>
What are the levers that can be pulled at the higher levels of the system?

How can interactions between components be improved?

What conditions can be improved on the front line?
3 Phase Program of Research

1. Identification of the Human Factors issues involved in accidents and incidents (see *Salmon et al, 2009*);

2. Establishment of industry database and integration of industry reporting with database;

3. Implementation of measures to reduce injury and support ongoing reporting of incident data
UPLOADS - What if?

- We all collected detailed systems data on injury and near miss incidents....

- Analysed this data using a valid, systems-based accident analysis framework....

- Shared these analyses with one another and talked openly about accident causation and near misses

- Fixed the led outdoor activity system rather than components

- Reported often on countermeasures and their success....
• Australian Research Council Linkage project

• Development, validation and trial of injury surveillance system for led outdoor activity industry in Australia

• Development & validation of accident causation model
UPLOADS project

1. **Methodological development.** Prototype incident reporting, storage and analysis methods will be developed, forming a prototype accident & injury surveillance system;

2. **Methodological validation and refinement.** Surveillance system methods will be trialled and refined using led outdoor activity injury incident data;

3. **In-depth incident study.** Injury surveillance system will be implemented in order to conduct an in-depth study of injury causing incidents in the led outdoor activity domain in Australia; and

4. **Accident causation model development.** Based on the findings, a systems-based model of injury incident causation for the led outdoor activity domain will be developed.
Instructor/Safety manager

Data collection

Led Outdoor Activity Providers

Instructor/Safety manager

Report incident

Organisation’s data system

Auto de-identification

Activity Incident
Contribution factors

 UPLOADS system

Data analysis

Reporting of aggregate data

UPLOADS framework

*Note: organisations can run their own in-house analyses using own organisation level database

Standardised incident/near miss reporting form

Organisation level database

UPLOADS aggregate database

UPLOADS annual report

Periodic reporting to industry

Ad hoc data requests

*Note data is non-identifiable regarding organisations, instructors, participants etc

*Note reporting shows aggregate data only and is non-identifiable
UPLOADS – Key characteristics

- Systems-based
- Underpinned by Just Culture philosophy
- Use contemporary, valid accident analysis methods
UPLOADS development

• **Data driven**
  - Analysis of existing led outdoor activity accident data

• **Theory driven**
  - Review of accident causation theory

• **Domain expert driven**
  - Delphi study (expert consensus)
Domain expert Delphi study

- Literature review to identify characteristics of accident/injury databases/surveillance systems
- Delphi study to identify industry/SME perspectives
- 25 participants (25 different organisations, VIC, NSW, WA, QLD)
- Current practice, UPLOADS scope, and desirable characteristics
Results

- Multiple definitions of an ‘incident’, ‘near miss’, and ‘injury’
- UPLOADS systems should include incidents and near misses
- System should be paper + electronic (Smart Phone App highly desirable)
- Combination of on-line and hands on training required
## Desirable characteristics - Essential

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Essential (%)</th>
<th>Desirable (%)</th>
<th>Not required (%)</th>
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<tbody>
<tr>
<td>Representativeness</td>
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<tr>
<td>Clear case definitions</td>
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<tr>
<td>Ease of reporting</td>
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<tr>
<td>Usefulness</td>
<td>96</td>
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<tr>
<td>Utility</td>
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<tr>
<td>Credible</td>
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<td>Sustainability (system)</td>
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<td>Positive predictive value</td>
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<tr>
<td>Use of uniform classification systems</td>
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<td>Simplicity</td>
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<tr>
<td>Independent</td>
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<td>16</td>
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<tr>
<td>Data confidentiality and individual privacy</td>
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<tr>
<td>Guidance material for data interpretation</td>
<td>80</td>
<td>20</td>
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## Less important characteristics

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<thead>
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<th>Score 1</th>
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</tr>
<tr>
<td>Data collection process described</td>
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<tr>
<td>Sensitivity</td>
<td>68</td>
<td>32</td>
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</tr>
<tr>
<td>System security</td>
<td>68</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>Systems–oriented</td>
<td>68</td>
<td>28</td>
<td>4</td>
</tr>
<tr>
<td>Flexibility</td>
<td>60</td>
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<tr>
<td>Stability of the system</td>
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<tr>
<td>Sustainability (sustained leadership support)</td>
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<tr>
<td>Data completeness</td>
<td>56</td>
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<td>Quality control measures</td>
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<tr>
<td>Expert analysis</td>
<td>48</td>
<td>40</td>
<td>12</td>
</tr>
<tr>
<td>Accessibility</td>
<td>48</td>
<td>52</td>
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<tr>
<td>Availability</td>
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<td>60</td>
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<tr>
<td>Acceptability</td>
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<td>56</td>
<td>4</td>
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<tr>
<td>Specificity</td>
<td>36</td>
<td>56</td>
<td>8</td>
</tr>
<tr>
<td>Timeliness</td>
<td>28</td>
<td>68</td>
<td>4</td>
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<tr>
<td>Responsive</td>
<td>28</td>
<td>64</td>
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</table>
Round 2 – UPLOADS *MUST* have

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<tr>
<td>Data collection process described</td>
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<td>0%</td>
</tr>
<tr>
<td>Flexibility</td>
<td>100.00%</td>
<td>0%</td>
</tr>
<tr>
<td>Accessibility</td>
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<td>0%</td>
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<tr>
<td>Stability of the system</td>
<td>94.70%</td>
<td>5.30%</td>
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<td>Systems–oriented</td>
<td>89.50%</td>
<td>10.50%</td>
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</tr>
<tr>
<td>Quality control measures</td>
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</tr>
<tr>
<td>System security</td>
<td>84.20%</td>
<td>15.80%</td>
</tr>
<tr>
<td>Data completeness</td>
<td>84.20%</td>
<td>15.80%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>78.90%</td>
<td>21.10%</td>
</tr>
<tr>
<td>Availability</td>
<td>78.90%</td>
<td>21.10%</td>
</tr>
<tr>
<td>Specificity</td>
<td>73.70%</td>
<td>26.30%</td>
</tr>
<tr>
<td>Timeliness</td>
<td>73.70%</td>
<td>26.30%</td>
</tr>
<tr>
<td>Expert analysis</td>
<td>68.40%</td>
<td>31.60%</td>
</tr>
<tr>
<td>Responsive</td>
<td>68.40%</td>
<td>31.60%</td>
</tr>
<tr>
<td>Acceptability</td>
<td>63.20%</td>
<td>36.80%</td>
</tr>
</tbody>
</table>
Data Driven – Systems analysis of existing data

- New Zealand Outdoor Education/Recreation data
- Jan 2007 – Dec 2011, 1017 cases (Data de-identified)
- Australian data
- Data coded by 3 analysts
- Frequency counts
Incident type (NZ)
## Activities (NZ)

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Injury</th>
<th>Illness</th>
<th>Near Miss</th>
<th>Fatalities</th>
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</thead>
<tbody>
<tr>
<td>Miscellaneous</td>
<td>15</td>
<td>5</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Ball sports</td>
<td>10</td>
<td>1</td>
<td>70</td>
<td>0</td>
</tr>
<tr>
<td>Free time</td>
<td>65</td>
<td>7</td>
<td>47</td>
<td>0</td>
</tr>
<tr>
<td>Climbing activities</td>
<td>43</td>
<td>3</td>
<td>190</td>
<td>1</td>
</tr>
<tr>
<td>Walking/Running activities</td>
<td>166</td>
<td>27</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Weapons</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Camping activities</td>
<td>39</td>
<td>78</td>
<td>91</td>
<td>0</td>
</tr>
<tr>
<td>Boating activities</td>
<td>76</td>
<td>14</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>Caving</td>
<td>21</td>
<td>9</td>
<td>37</td>
<td>0</td>
</tr>
<tr>
<td>Swimming</td>
<td>32</td>
<td>6</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>Cycling</td>
<td>27</td>
<td>1</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td>Ropes</td>
<td>32</td>
<td>6</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>Skiing/Boarding</td>
<td>21</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Horse riding</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Initiatives</td>
<td>41</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Motor bikes</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>596</strong></td>
<td><strong>161</strong></td>
<td><strong>560</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>
Injury (NZ)
Causal factors (NZ)

- Average causal factors: 4.1
- Environment and actor: 75.7
- Technical and operational: 91.4
- Local area govt and...: 12.2
- Regulatory bodies and...: 12.2
- Government policy and...: 2
- Physical processes and...: 1.4
Most common factors (NZ)

- Hazardous terrain
- Instructor judgement errors
- Participant unsafe acts
## Contributing factors (NZ)

<table>
<thead>
<tr>
<th>Category</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Policy and Budgeting</td>
<td>Government Actions (12) Action of other companies (2)</td>
</tr>
<tr>
<td>Regulatory Bodies and Associations</td>
<td>Industry body failures (2)</td>
</tr>
<tr>
<td>Local area government, parents, schools and activity centre management</td>
<td>Company policy failures (27) Company systems (74) Parent factors (13)</td>
</tr>
<tr>
<td>Technical and operational management</td>
<td>Poor planning (82) Operational management factors (39) Site maintenance (1)</td>
</tr>
<tr>
<td>Physical processes and instructor/participant activities</td>
<td>Participant factors (834) Instructor factors (499) Leader factors (4)</td>
</tr>
<tr>
<td></td>
<td>Group factors (30) Communication failures (51) Otheractors (30)</td>
</tr>
<tr>
<td></td>
<td>Supervisor factors (179)</td>
</tr>
</tbody>
</table>

Causal factors identified across all levels of framework

High emphasis on direct causal factors at the sharp end

Participants are evil!
### Contributing factors (Australian)

<table>
<thead>
<tr>
<th>Category</th>
<th>Contributing Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Policy and Budgeting</td>
<td></td>
</tr>
<tr>
<td>Regulatory Bodies and Associations</td>
<td></td>
</tr>
<tr>
<td>Local area government, parents, schools and activity centre management, planning and budgeting</td>
<td>Parents (1), Risk management systems (3)</td>
</tr>
<tr>
<td>Technical and operational management</td>
<td>Staff shortages (2), Planning failures (2), Poor comms with participants (2)</td>
</tr>
<tr>
<td>Physical processes and instructor/participant activities</td>
<td>Instructors (29), Participants (243), Communications (4), Teamwork (1)</td>
</tr>
<tr>
<td>Equipment and surroundings</td>
<td>Equipment (15), Weather (2), Hazardous terrain (12), Animal hazard (13), Water hazard (59)</td>
</tr>
</tbody>
</table>

**Lack of causal factors outside of equipment, environment, participants and instructors**

**Australian participants are even worse!!!**
Equipment and Surroundings

- **Inadequate equipment**
  - Lack of, poor condition, inadequate design
- **Inappropriate equipment**
  - Wrong equipment for activity, Poor fitting equipment, faulty/sub-standard equipment
- **Terrain**
  - Wet/slippery, unsafe roads, trees and branches, rough terrain, rocks under water, Sheep!
- **Temperature**
- **Water**
- **Weather**
Physical processes and actor activities

- **Group**
  - Size, Skills, teamwork, communications, peer pressure

- **Participants**
  - Unsafe acts & violations
  - Physical condition, fatigue, pre-existing injuries, mental condition
  - Poor judgement, SA, lack of skills, inattention, complacency
  - Poor technique, fail to follow/misunderstood instructions

- **Instructors**
  - Unsafe acts & violations, attitude, lack of skills
  - Physical condition, fatigue, pre-existing injuries, mental condition
  - Poor judgement, distraction etc
Technical and Operational Management

• Poor planning
  - Group size, participant screening, knowledge of participants
  - Staff to participant ratio
  - Poor contingency planning

• Procedures
  - Use of procedures known to cause injury
  - Poor design of activity, selection of equipment
  - Absence of procedures
  - Failure to follow/enforce procedures

• Supervision, Training, Experience
Higher level factors

• Local area govt and company management
  - Training programs
  - Hazard management systems
  - Policies and communication of policies
• Regulatory bodies and associations
  - Parents
  - Failure of other organisations
• Govt Policy
  - Failure to fulfill policy requirement
Lessons learnt for UPLOADS database

- Issues unique to this population - bullying, child psychology issues, teacher-student relationships as causes of incidents
- Mis-classification of activities e.g. ‘camping’, ‘initiatives’
- Tendency not to report instructor role
- Judgement error a default code
- More factors identified in the narrative than via causal factors specified
- Insufficient data to ascertain what happened e.g. ‘sprained ankle’
- Little insight into higher level factors
- Lack of insight into the causes of accidents generally e.g. ‘Bad luck’
UPLOADING Accimap

• Develop taxonomies of factors at each Accimap level based on:
  1. Analysis of existing outdoor ed incident data;
  2. Review of the literature on outdoor ed accident causation frameworks/taxonomies;
  3. Review of general accident causation/taxonomy literature; and
  4. Review of accident analysis methods
• Test and refine taxonomies throughout
• Taxonomies will grow during 6 month test of system
## Outdoor Ed Actor-Map

### Government Policy and Budgeting
- Government bodies
- State Departments of Education e.g. Dept of Education and ECD
- State Departments of Land Management e.g. Parks Vic

### Regulatory Bodies and Associations
- Regulatory bodies
- Accreditation bodies
- Auditing bodies
- Peak bodies for outdoor recreation, outdoor education, and adventure tourism
- Victorian Adventure Activity Standards
- Standards Australia
- Outdoor Council of Australia (e.g. National outdoor leaders reg scheme)

### Local area government, parents, schools and activity centre management, planning and budgeting
- Activity centre senior management/board level
- Local Govt & councils
- Schools, school principals and school councils
- Parents
- Emergency services

### Technical and operational management
- Supervisors
- Managers (e.g. programs, training, risk, teaching)

### Physical processes and instructor/participant activities level
- Instructor
- Participants
- Group

### Physical processes and instructor/participant activities level
- Equipment
- Physical environment
- Meteorological conditions
- Ambient conditions
Life jackets were the wrong kind for the activity and were not inflated as required
Taxonomies

- Equipment and surroundings;
- Physical processes and instructor/participant activities;
- Technical and operational management;
- Local area government, activity centre management planning and budgeting, schools and parents;
- Regulatory bodies and associations; and
- Government policy and budgeting
Equipment and surroundings

- Equipment and materials
- Physical environment
- Ambient and Meteorological conditions

Activity equipment
- Lack of equipment
- Inadequate equipment
- Inappropriate equipment
- Faulty/Broken equipment
- Failure to use equipment
- Equipment not used properly
- New/unfamiliar equipment
- Other
Participants and instructors

- Planning and preparation
- Experience, qualifications and competence
- Perception
- Decision
- Action
- Communications
- Physical condition
- Mental condition
- Violations
- Other
Next steps

• Refining taxonomies (now)

• Build UPLOADS system (Oct – Dec 2012)

• Phase 2 - 6 month trial of UPLOADS system (Jan 2013)
Summary

- Industries knowledge of accident causation limited
- Appropriate databases sparse (non existent in Australia)
- Systems approach and methods required for incident reporting and analysis
- Unified industry database required
- UPLOADS project is developing this database
- System will be trialled for the first 6 months of 2013
Take home messages

• Incident reporting and analysis critical for safe and efficient systems

• Incident reporting systems not underpinned by appropriate theory and methods can do more harm than good

• Take a systems approach on incident reporting, analysis, and countermeasure development

• Sharing data and communicating analyses is imperative
Thanks for the opportunity!

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