National Association of State Boating Law Administrators
Engineering, Reporting & Analysis Committee

Four Key Boating Accident and Fatality Research Questions: *An exploration of how to answer them, available data, and recommendations for future research and data improvements* (August 2010)

EXECUTIVE SUMMARY

THE CHARGE

Identify key **accident-, injury-, and fatality-related research questions** that are critical to developing or refining work being conducted by ERAC and other NASBLA committees and that are components of national efforts to improve boating safety.

Audit the current BARD-Web database (U.S. Coast Guard Boating Accident Report Database) to determine whether **adequate and sufficient data are available to answer those questions**.

Conduct analyses on the identified questions, as feasible, and **develop recommendations** for improving BARD-Web; for using BARD-Web to answer such questions; or for using other data sources in the case of questions that cannot be answered through BARD-Web.

THE APPROACH

After thorough review and consideration of the 2007-2011 Strategic Plan of the National Recreational Boating Safety Program, the proposed revisions to the Strategic Plan for 2012-2016, the 2010 NASBLA committee charges, and research questions identified in 2009 work, the ERAC team assigned to this charge developed a lengthy list of potential research questions to explore. Each question was evaluated based on its scope and overall value. Four were selected to work on during the 2010 committee cycle:

- How many accidents and/or fatalities occur each year that can be attributed to violations of the Navigation Rules (and to specific types of violations)? (pp. 4-6)
- How many accidents and/or fatalities occur each year that can be attributed to the lack of required carriage equipment? (pp. 7-9)
- Do boating areas with higher life jacket wear rates have a lower incidence of recreational boating fatalities? (pp. 10-12)
- What human factors are most likely to result in accidents and/or fatalities? (pp. 13-24)

All remaining research questions were documented and set aside for future consideration.

To inform and organize its work, the charge team developed, and attempted to answer, a series of exploratory questions to define the parameters for the four selected research questions. The team asked:

- **Why** is this research question **important** enough to be considered?
- How are we **defining the critical terms** in this question—that is, what do we "**mean**" when we ask the question? What are we really talking about **measuring**?
- What **data**, if any, are we **currently capturing** that might answer this question? And what, if any **caveats or stipulations** need to be put on the data?
- What **recommendations** do we have with regard to the **accuracy/validity** of answering this question this way and how the process can be **refined/enhanced/improved** in the future?

RECOMMENDATIONS

During the 2010 committee cycle, the charge team did not expect to progress to the point of conducting full-fledged analyses on the four selected research questions. However, the process of exploring the concepts behind these questions, the terms used, and the availability and applicability of existing data, yielded four mini-reports, all of which are included at the end of this executive summary.

While all of the reports have recommendations specific to each, some over-arching themes emerged:

- To improve the accuracy and validity of any analysis that uses BARD-Web data, **clear definitions for all terms and categories** should be established, disseminated and communicated to all persons involved in the data collection and data entry processes for BARD-Web. This includes the persons who complete the BAR form (boat operator/owner and/or officer/investigator); the persons who review the accident report information (the officer/investigator and/or data analyst/data entry personnel); and the persons who enter the information into BARD-Web. [1]

- Related to the above, and in the interest of better establishing the existence of any bias or validity issues in the data, it also would be beneficial to more accurately record the source of the report data in BARD-Web, and perhaps standardizing the responses to include "Owner," "Operator" or "Officer/Investigator".

- Any future changes to the design of the BAR form should be scrutinized for their potential effects on baseline data already established in BARD-Web (e.g., adding and/or removing categories within a data field).

- Current information in BARD-Web needs to be more fully explored and analyzed, especially in the area of human factors.

- As with BARD-Web, any analysis using the U.S. Coast Guard Performance Report Part II data would benefit from standardized definitions of applicable terms and processes in order to attain the highest quality data. Such data analyses also would benefit from an understanding of the variance among the states with regard to their stance on education and enforcement; otherwise, sweeping and invalid assumptions might be made about the data.

[1] This recommendation is in support of work to update and clarify definitions of BAR terms and categories on accident types, contributing factors/causes, vessel types, activity, and operation, as initiated by another ERAC team in 2009, continuing into 2010.

- Although valuable data collections, in the form of BARD-Web and Performance Report Part II statistics, are available to begin the analysis of critical boating safety research questions, efforts should continue toward developing additional, more inclusive, and potentially more reliable data sources to answer these and other important questions in the future (e.g., in the case of life jacket wear studies).

Along with these content and data recommendations, the ERAC charge team further recommends:

As resources permit in future committee cycles, or as opportunities arise as a result of partnerships, that a full analysis on each of the four key research questions be conducted; that the mini-reports—with the exploratory questions—be used as a template for future work on other recreational boating data analysis issues; and that these mini-reports, as well as other resources and documents identified through their development, be incorporated and transformed into an online, interactive network or forum to expand the discussion with other governmental, non-profit and academic researchers and users of boating accident and related data.

Research Question —How many accidents and/or fatalities occur each year that can be attributed to navigation rules violations (and to specific types of violations)?

Why is the research question important enough to consider?

Factors associated with "navigation rules violations" continue to "rise to the top" when considering those that lead to accidents and casualties. In addition, the issue is currently a component in the Strategic Plan of the National Recreational Boating Safety Program for 2007-2011 (Objective 5 re: Operator Compliance – Navigation Rules) and is being updated for inclusion in the 2012-2016 Strategic Plan.

How are we defining the critical terms in this question? (that is, what do we 'mean' when we ask this question?; what are we really talking about measuring?)

To get at the concept of "navigation rules violations" (or alternately, "navigation rules infractions," or "rules of the road violations or infractions"), several primary contributing factors could provide a more complete picture. As such, they should be included in the data set used to analyze this research question. For example:

BAR Form Entry	Possible/Probable Violation of
Excessive speed	Rule 6—Safe Speed
Lack of or improper boat lights	Any of several rules in Part C or Annex I
No proper lookout	Rule 5—Look-out
Operator inattention	Rule 5—Look-out
[Failure to yield] [1]	Rule 7—Risk of Collision Rule 8—Action to avoid collision Rule 13—Overtaking Rule 14—Head-on Situation Rule 15—Crossing situation Rule 16—Action by Give Way Vessel Rule 18—Responsibilities Between Vessels

Records using the catch-all contributing factor category "**Rules of the Road Infractions**" and records of other accidents involving two vessels that resulted in a collision (with the caveat that both vessels were in operation/motion at the time of the collision) also should also be included in the data set. Filtering any of the included records by whether or not an actual citation was issued in the incident is not recommended due to the inconsistencies in writing such citations, as well as documenting citations that are made.

[1] An audit of BARD-Web data shows that "Failure to yield" or "Fail to yield" has been used only infrequently by the states since its inclusion on one version of the BAR form CG 3865 (rev. 12-06). The entry, like another umbrella term "Careless/Reckless Operation" (which appeared on BAR form versions prior to 2008) covers several possible navigation rules violations. It would be preferable—in future accident reporting forms—to provide more specificity than what can be provided with such umbrella terms.

Moving into the 2010 and beyond BARD-Web data, the two items listed in the previous paragraph ("**Rules of the Road Infractions**" and two-vessel collisions where both vessels were in motion) should be used to verify correctly-applied contributing factor coding on accidents.

Additional adjustments will need to be made to the contributing factor categories included in such an analysis if the NASBLA ERAC 2009 Charge One team recommendations with regard to contributing factor categories and definitions are accepted and implemented within the BARD-Web framework.

What data, if any, are we currently capturing that might answer this question? And, what, if any, caveats or stipulations need to be put on the data?

The primary data relevant to this question can be found in the BARD-Web "Primary Accident Cause" data field. Although the completion rate on this data field is 100 percent (as derived from the 2003-2007 data), there still remain a large fraction of accidents where "Unknown" is listed as the primary causative factor (1414/25469; 5.55%).

For reference, the breakdown of primary accident causes (highlighting those identified in the above discussion) is as follows for the 2003-2007 BARD-Web reporting period:

Primary Accident Cause in Accidents, 2003-2007						
	2003	2004	2005	2006	2007	2003-2007
Alcohol Use	289	296	366	351	391	1693
Careless/Reckless Operation	486	570	639	517	552	2764
Congested Waters	62	40	66	85	107	360
Dam/Lock	13	18	3	3	14	51
Drug use	4	5	2	2	5	18
Equipment Failure	145	132	124	141	141	683
Excessive Speed	446	401	432	464	473	2216
Failure to Vent	13	13	19	24	17	86
Force of wave/wake	121	105	120	116	128	590
Hazardous Waters	356	312	327	294	83	1372
Hull Failure	68	69	67	77	60	341
Ignition of Spilled Fuel or Vapor	43	64	40	36	31	214
Improper Anchoring	32	49	36	27	43	187
IMPROPER LOADING	42	36	53	39	49	219
Lack of or improper lights	21	27	16	17	18	99
Machinery Failure	241	285	273	272	312	1383
No proper lookout	326	271	314	368	375	1654
Operator Inattention	703	562	568	611	628	3072
Operator Inexperience	477	406	429	356	353	2021
Other	162	193	92	166	305	918
Overloading	36	36	26	30	33	161
Passenger/Skier Behavior	331	291	384	390	492	1888
Restricted Vision	60	69	50	64	69	312
Rules of the Road Infraction	199	188	132	46	54	619
SHARP TURN	64	43	39	47	51	244
Standing/Sitting on gunwales, bow, transom	25	20	29	28	12	114

Unknown	489	225	180	273	247	1414
Weather	184	178	143	123	148	776
Grand Total	5438	4904	4969	4967	5191	25469

What recommendations do we have with regard to the accuracy/validity of "answering" the question this way and how the process can be refined/enhanced/improved in the future?

In order to improve the accuracy and validity of any analysis on the data identified here, clear definitions for all terminology/categories must be established, disseminated and communicated to all persons involved in the data collection and data entry processes for BARD-Web. That includes the boat operator/owner or officer filling out the form, the officer/investigator reviewing the form, and the data analyst reviewing and entering the record information into BARD-Web. In the interest of better establishing any bias and/or validity issues in the data, it would also be beneficial to more accurately record the source of the data in BARD-Web (perhaps standardizing the responses to include "Owner," "Operator" or "Officer/Investigator").

It also is necessary to track any modifications to the design of the accident reporting forms, because, as a result of current work to redesign the accident reporting structure, these may change again in the future. That said, in future modifications, it would be preferable to try to capture the diversity of the probable or possible violations of the navigation rules rather than to create and use an umbrella term to represent multiple violations.

Research Question —How many accidents and/or fatalities occur each year that can be attributed to the lack of required carriage equipment?

Why is the research question important enough to consider?

Factors associated with required carriage equipment violations continue to be a significant education and law enforcement issue. In addition, the lack of required carriage equipment may result in property damage or injuries [(burns) (fire extinguisher)] or death [(life jacket carriage)]. This issue is currently being addressed through multiple components in the Strategic Plan of the National Recreational Boating Safety Program for 2007-2011 (Objective 4, strategy 4.9 Strict Enforcement of Life Jacket Carriage and Wear Laws; Objective 8 Operator Compliance-USCG Required Safety Equipment with Strategy 8.1 Evaluate Incidents of Non-Compliance with Required Safety Equipment, Strategy 8.2 Target Problem Compliance Areas, and Strategy 8.3 Enforcement Patrols). Also under consideration is a revision to Objective 9 for the 2012-2016 USCG Strategic Plan cycle: "Required Essential Elements of Information" that will capture many carriage requirements. These objectives are being evaluated for success or gaps in reducing boating accident property damage, injuries or fatalities for inclusion in the 2012-2016 plan.

How are we defining the critical terms in this question? (that is, what do we 'mean' when we ask this question?; what are we really talking about measuring?)

Firm definitions for the elements of this question and their relevant data are still under consideration and being researched by several groups, including the National Boating Safety Advisory Council (NBSAC) Strategic Planning Review Task Force (Objective 8 Working Group). Among the data concerns being taken into consideration are those discussed in the NASBLA ERAC 2009 Charge Two Report. The report addresses the use of BARD-Web and Performance Report Part II data, as well as the use of Marine Information for Safety and Law Enforcement (MISLE) and associated state-level vessel inspection data to measure operator compliance with the carriage requirements. The NBSAC Strategic Planning Review Task Force has drafted suggestions to address some of these areas of concern in Objective 9 of the new (2012-2016) USCG Strategic Plan.

What data, if any, are we currently capturing that might answer this question? And, what, if any, caveats or stipulations need to be put on the data?

At this time, the most relevant sources of data appear to be the Performance Report Part II statistics provided by the states to the U.S. Coast Guard for federal fiscal years 2008 and 2009 (especially the data elements pertaining to carriage equipment citations and warnings); and certain components of BARD-Web data pertaining to life jacket wear, fire extinguisher availability, and accident cause data. The first set of data (Performance Report Part II) provide a general idea of the number of times that equipment is missing, as discovered through routine law enforcement and as reported by the states, and that could *potentially* result in an accident, injury, or fatality; the second set of data (BARD-Web) provides an indication of the

number of accidents, injuries, and fatalities that can *potentially* be linked (directly or indirectly) to a lack of required carriage equipment.

With regard to the Performance Report Part II data, although this data set is "complete"—in in that all states provide information—researchers who choose to use these data should exercise caution. The number of citations and warnings issued can be influenced by the policies and procedures implemented by different state agencies,(especially in the areas of law enforcement and education); and there have been questions raised as to the reliability and validity of using the data to establish measures of operator compliance with the carriage requirements (see NASBLA ERAC 2009 Charge Two report).

With regard to the BARD-Web data, current data fields that could be used in considering this question (and their applicable completion rates for the period 2003-2007) are as follows:

Carriage Equipment Information in Accidents, 03-07			
Table: Vessel (34,301 records)			
	Yes	No*	Unknown
CG PFDs on board?	21062	13289	50
PFDs Accessible?	16805	17126	470
Fire Extinguishers/Board	13165	21176	60
Fire Extinguishers/Used	1113	33228	60

PFD Use for Deceased Victims in Accidents, 03-07	
Table: Deceased (3,471 records)	
Yes	629
No*	2842

** Could potentially be a "default" for the system, rather than a true data entry*

In addition, the Accident Cause field may be useful when considering navigation lights (will indicate "Lack of or improper boat lights" when insufficient and/or improper lights are shown by a boat that indicate course, position, and occupation, such as fishing or towing) and Fire Extinguisher issues (will indicate "Equipment Failure" with a subcategory of "Fire Extinguishers not serviceable). The completion rate on this field in the 2003-2007 data set was 100 percent (although 1414/25469; 5.55% of records indicated the cause of the accident was "Unknown").

Should a full set of Vessel Safety Check data (including notations on equipment carriage requirement details) become available through sources such as the U.S. Coast Guard Auxiliary, such data could also prove useful in answering questions on this issue in the future.

What recommendations do we have with regard to the accuracy/validity of "answering" the question this way and how the process can be refined/enhanced/improved in the future?

To improve the accuracy and validity of any analysis performed on the data defined here, clear definitions for all terminology/categories must be established, disseminated and communicated to all persons involved in the data collection and data entry processes for BARD-Web. That includes the boat operator/owner or officer filling out the form, the officer/investigator reviewing the form, and the data analyst reviewing and entering the record information into BARD-Web. In the interest of better establishing any bias and/or validity issues in the data, it would also be beneficial to more accurately record the source of the data in BARD-Web (perhaps standardizing the responses to include "Owner", "Operator" or "Officer/Investigator"). The same points regarding terminology and definitions can be made for any other potential measurement tools including, but not limited to the Performance Report Part II data and MISLE data.

With regard to the variances in the way USCG Part II Performance Report data currently are collected at the state level, the standardization of definitions and processes would improve the quality of data for analysis. Additionally, the National Boating Safety Advisory Council (NBSAC) Strategic Planning Task Force, weighing in on questions raised about the suitability of the data for establishing trends and measures of operator non-compliance, noted that efforts in this area should continue to attempt to gain valid, reliable baseline data on compliance, including possible new means for gathering these data. New research (perhaps using focus groups) should also be conducted to examine what efforts would significantly "move the needle" and increase compliance by boaters.

Regarding the BARD-Web data, emphasis should be given to collecting predominantly officer-generated (and presumably more reliable and objective) data and ensuring completion of all data fields. In addition, changes to the BARD-Web database structure could help eliminate any doubt in "No" responses (which could be the default answer rather than the actual response by data entry personnel). Finally, as per revisions to Objective 9 of the Strategic Plan of the National Recreational Boating Safety Program for 2012-2016 (currently under consideration), additional carriage requirement details could also be incorporated into the BARD-Web system to collect data for future analysis; however care should be taken to assure that any additional data being collected are actually used in this effort.

Finally, NASBLA/ERAC should continue to participate in the development and implementation of elements of Objective 8, Operator Compliance, and Objective 9, Accident Reporting of the National RBS Strategic Plan.

Research Question —Do boating areas with higher life jacket wear rates have a lower incidence of recreational boating fatalities?

Why is the research question important enough to consider?

A large proportion of persons who drown during recreational boating activities are not wearing a life jacket at the time of their death. It is widely believed that wearing life jackets could have prevented many of these operator/passenger drownings.

In addition, factors associated with required carriage equipment violations continue to be a significant education and law enforcement issue considering that the lack of carriage may lead to injuries or death (life jacket carriage). This issue is currently a component in the Strategic Plan of the National Recreational Boating Safety Program for 2007-2011 (Objective 4 re: Life Jacket Wear) and is being updated for inclusion in the 2012-2016 Strategic Plan.

How are we defining the critical terms in this question? (that is, what do we 'mean' when we ask this question?; what are we really talking about measuring?)

Fundamentally, this question is trying to determine whether social marketing campaigns and law enforcement efforts designed to increase life jacket wear have a corresponding effect on lowering the fatalities resulting from recreational boating accidents in the targeted area(s).

Because this question is complex, and may include human factors as well as geographical and cultural factors, several parameters need to be considered when trying to answer this question. These include, but are not limited to:

- What is a "boating area" (regional, state, national)?
- What is a "fatality" (drowning, accident, undetermined)?
- What is a "recreational boating fatality" (swimming from boat, people being towed)?
- What is considered a "higher life jacket rate" (percentage/penetration and compared to what)?
- What is meant by "mandatory wear" versus "voluntary wear" (who, when)?

These parameters need to be objectively identified and defined in order to be sure that all parties are appropriately submitting and analyzing the resulting data. Care also must be taken to consider additional intangible qualities of the locale being studied (e.g., local boating population or transient boating population?) and the population being targeted (e.g., age, gender, race) when making comparisons between areas. Additionally, differences in the states' life jackets laws, as well as variances in enforcement stance between areas should also be considered in analysis.

Alternative questions are likely to arise from preliminary study on this issue, including: "Are there successful models for increasing life jacket wear voluntarily?" and "Would mandatory life jacket wear be effective in lowering recreational boating fatalities?"

What data, if any, are we currently capturing that might answer this question? And, what, if any, caveats or stipulations need to be put on the data?

Three primary sources of information currently available are: BARD-Web, U.S. Coast Guard Performance Report Part II data, and reports/studies related to life jacket wear rates before and after national (JSI) and state/local "Wear It!" voluntary life jacket wear campaigns.

On the national level, BARD-Web and the USCG Part II Performance Report both capture data regarding life jacket wear. The former collects data on whether Operators and/or Victims involved in recreational boating accidents were wearing life jackets at the time of the incident and/or whether life jackets were accessible or used following the incident. The latter provides an indication of the number of life jacket carriage requirement warnings and violations issued within a state for a given year. Unfortunately, both of these datasets are somewhat skewed--BARD-Web only captures data on those persons who are actually involved in a reportable boating accident, while Performance Report Part II only captures data on those persons aboard vessels that are stopped for a violation or contacted/boarded for an inspection. Both of these groups are only subsets of the entire recreational boating population and are by no means unbiased or random samples.

Looking at the BARD-Web data, the following completion rates for applicable data fields as pulled from the 2003-2007 BARD-Web data should also be considered when attempting to complete any analysis using this data:

Carriage Equipment Information in Accidents, 03-07			
Table: Vessel (34,301 records)			
	Yes	No*	Unknown
CG PFDs onboard?	21062	13289	50
PFDs Accessible?	16805	17126	470
Fire Extinguishers/Board	13165	21176	60
Fire Extinguishers/Used	1113	33228	60

PFD Use for Deceased Victims in Accidents, 03-07	
Table: Deceased (3,471 records)	
Yes	629
No*	2842

** Could potentially be a "default" for the system, rather than a true data entry*

With regard to the USCG Part II Performance Report data, although this data set is "complete" (all states providing information) researchers choosing to use this set of data should remember that the number of citations and warnings in any given state for life jacket carriage

can be influenced by differences in state law, as well as the policies and procedures implemented by different state agencies (especially in the areas of law enforcement and education). Weather and the economy, as well as other transient influences, can also have an impact on these figures from year to year. Additionally, it should also be noted that the original intent of the information collected for the USCG Part II Performance Report was not for analysis purposes related to establishing trends in non-compliance with carriage equipment requirements and therefore may not be suitable for this task.

Finally, with regard to the "Wear It!" reports and studies completed both on a "national" level (JSI) and at a state/local level, many of these tools offer only an incomplete snapshot of life jacket wear for the area being studied. This snapshot is often limited by the length of time over which the life jacket wear rate measurement is made (e.g., one day out of the year – leading to potential fluctuations if the weather on the chosen day varies annually), and/or the limited geographical area being used as representative of the life jacket wear rate over a larger geographical area (e.g., using a target lake's life jacket wear rate to represent a larger geographic area such as a region or state – which may or may not be accurate dependent on variance within the qualities of the bodies of water and the populations using those bodies of water).

What recommendations do we have with regard to the accuracy/validity of "answering" the question this way and how the process can be refined/enhanced/improved in the future?

Based on the fact that the current data available are often incomplete, inherently skewed with regard to the population sample, and/or limited for purposes of extrapolation, efforts should be made to develop additional, more inclusive, and more reliable data sources to answer this question. If it is absolutely essential to use existing data to begin exploring this issue, then the caveats mentioned previously should be considered and mentioned in any analysis. Additionally, caution should be used in making causative and/or correlation statements regarding the data.

In the future, to ensure more complete and accurate data and analyses of the connections between life jacket wear rates and recreational boating fatalities, it might be helpful to also answer questions such as these:

- Was a life jacket available for each passenger aboard?
- Was a life jacket worn by the injured/deceased victim?
- Was it required to have been worn by the injured/deceased victim prior to the incident?
- Was the victim (if they survived) issued a citation for not wearing a life jacket?
- What characteristics may influence people to wear a life jacket?

Research Question —What human factors are most likely to result in accidents and fatalities?

Why is the research question important enough to consider?

Modern research into the causes and contributing factors of accidents (e.g., marine, aircraft, railway, and in various industries) indicates that human errors account for the vast majority of the causes and/or contributing factors. Table 1, for example, summarizes the findings of several researchers regarding the prevalence of human errors as accident causes or contributing factors.

Table 1. Estimates of human error (as % of all failures) in accidents in various industries/sectors

Source	Sector	% accidents related to human error
Flin, 2003	Jet transport Air traffic control Maritime vessels Chemical industry Nuclear power plants (US) Road transportation	65-85 90 80-85 80-90 70 85
Rothblum, 2002	Marine industries	• 84-88% of tanker accidents (Transportation Safety Board of Canada, 1994) • 79% of towing vessel groundings (Cormier, 1994) • 89-96% of collisions (Bryant, 1991; U.K. P&I Club, 1992) • 75% of allisions (Bryant, 1991) • 75% of fires and explosions (Bryant, 1991)

Human error in recreational boating accidents

McKnight *et al.* (2007) studied human errors in *recreational boating accidents* and, while no single, overall percentage of accidents associated with human error was given, it is clear from the research that human error played a significant role in the majority of these accidents (either as causes or contributing factors). For this reason, the study of human error is also important for the analysis of recreational boating accidents.

How are we defining the critical terms in this question? (that is, what do we 'mean' when we ask this question?; what are we really talking about measuring?)

The current BAR form provides a list of 31 possible "contributing factors" to a boating accident, several of which relate to human factors (including, but not limited to alcohol or drug use, operator inattention, and no proper lookout).

The U.S. Coast Guard, NASBLA, and other partners have made revisions to the BAR form over the years to enable a more accurate and relevant description of boating accidents. Recognizing the need to include more human factors information in the database, approximately five years ago, the Coast Guard and NASBLA developed a more complete list of possible human errors or violations thought applicable to boating accidents.

Table A-1 (see page 5), contains the current list of 69 specific errors or violations that are candidate descriptors of human errors or violations (more than one factor may be applicable to any given accident). The list of factors is similar to the list of human errors developed and analyzed by McKnight *et al*. (2007) and may have evolved at the same time.

What data, if any, are we currently capturing that might answer this question? And, what, if any, caveats or stipulations need to be put on the data?

The items contained in Table A-1 *are not data fields on the BAR form*, but rather are entered into the computer database in a special tab input currently in use by 30 states. These table entries can be retrieved from BARD and various tabulations can be prepared using these descriptors and any other entries to the BAR form.

The list of specific errors might be grouped into several categories, including ability/training, alcohol, navigation, and maintenance). Two key points are relevant:

1. *For the most part, these descriptors supply candidate answers to "what" rather than "why" questions*. For example, there are several entries in Table A-1 related to "lookout" that relate to particular failures, but none related to why these failures occurred (e.g., complacency, distraction, fixation with another problem in the boat, etc.).

2. *The candidate causes or contributing factors related to what are often termed preconditions for unsafe acts* (and more specifically condition of individuals) included in Table A-1 are limited to alcohol (also drugs). Certainly, alcohol is a known cause or contributing factor to boating accidents. The list of possible preconditions for unsafe acts is an excellent beginning, but arguably incomplete. For example, fatigue is

omitted from the list in Table A-1, even though numerous studies indicate that fatigue[1] can have many of the same debilitating effects as alcohol or drug use.

Regarding the first point above, the following questions are relevant:

- Is the list clear, understandable, and do we expect consistent and accurate coding? It would be helpful to have a glossary or manual with specific definitions and examples for this purpose, and to our knowledge no such manual exists.
- Is the list reasonably complete? That is, should other "what" questions be added to Table A-1?
- Should the list be amended (or should another list be added) to get at "why" as well as "what" questions? Are "what" questions adequate at our present level of development?

What recommendations do we have with regard to the accuracy/validity of "answering" the question this way and how the process can be refined/enhanced/improved in the future?

Several issues and potential areas for improvement are noted in the previous discussion. To begin, however, the following steps are recommended.

- Analyze the reporting data from participating states to see if there are gaps in the data and if there appears to be consistency in the human factor descriptors used.
- Tabulate the frequency of the descriptors to identify "high frequency" factors. This ranking may identify important causes/contributing factors. Factors that are coded with very low frequency might be candidates for omission.
- Prepare a list of definitions for the human factors descriptors, if necessary, to help ensure consistency when coding forms. Selected interviews with accident investigators could be used to identify factors that are regarded as ambiguous and need clarification.
- See if there are logical ways to group the data for summary analyses.
- Identify reason for lack of use of the human factors descriptors by the other 26 states/territories and search for ways to increase coverage.

[1] For a discussion of the effects of fatigue on driving, see http://ec.europa.eu/transport/wcm/road_safety/erso/knowledge/Content/55_fatique/effects_of_fatigue_on_driving.htm, http://monash.us/muarc/reports/papers/fatigue.html, or http://www.rospa.com/RoadSafety/info/fatigue.pdf. For effects on aviators, see http://aeromedical.org/Articles/Pilot_Fatigue.html, http://medind.nic.in/iab/t03/i1/iabt03i1p30.pdf, or http://www.ntsb.gov/Recs/mostwanted/aviation_reduce_acc_inc_humanfatig.htm. For a discussion of effects of fatigue in marine accidents, see http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA323392 or http://www.amsa.gov.au/shipping_safety/coastal_pilotage/fatigue_study_on_coastal_pilots/The_work_practices_of_Marine_Pilots/Pilot_Work_Practices-Results_3.asp.

From a longer term perspective, the literature on human factors has advanced dramatically in the past 20 years (see references attached). It would be appropriate to review this literature to see if there are useful ways to improve reporting of human factors data.

Table A-1. Human factors descriptors used by personnel from 30 States for entries in BARD for 2009 accidents.

1. **Ability: Operator—Setting out with an operator who clearly does not possess the ability needed for handling crew responsibilities, including sails, docking, and emergencies.**
2. **Ability: Others—Not making sure that passengers and crew possess the ability needed to avoid risk in the intended operation.**
3. **Alcohol: Operator—Becoming impaired by alcoholic beverages or certain drugs.**
4. **Anchor: Preparation—Not having the anchor ready to lower in the right manner.**
5. **Anchor: Type—Using inadequate ground tackle for the weather likely to be encountered (anchor of correct size and type and with adequate scope to prevent breakaway).**
6. **Anchor: Use—Not anchoring correctly, including lack of enough scope for wind.**
7. **Cannot identify error from information provided.**
8. **Capsized/swamped—Not remaining with the boat when capsized or swamped, or using the boat for flotation.**
9. **Control: Activities—Deliberate wave jumping or spraying, resulting in loss of control, falling from or striking vessel.**
10. **Control: Balance—Lack of proper steering, sail handling, or weight distribution to maintain balance.**
11. **Control: Maneuvering—Failing to maneuver properly in tight quarters, e.g. docking, anchoring, coming alongside other vessels, negotiating obstructions or clearing away from such situations.**
12. **Control: Power—Loss of steering because of power reduction e.g. jet propulsion.**
13. **Control: Turning—Turning too sharply and falling from or losing control of vessel (e.g. PWC).**
14. **Control: Wind/waves/current—Losing control in heavy wind or waves or strong current, resulting in fall or collision.**
15. **Distance: Land/structures—Keeping insufficient distance from land, shallow water, and structures such as docks, rocks, navigational aids.**

16. **Distance: Other boats—Not keeping insufficient distance from other boats to allow for wind, wave action, or other conditions that might result in collision.**
17. **Error not on list, enter description.**
18. **Give way: Collision—Failing to give way to avoid a collision.**
19. **Give way: Right-of-way—Failing to yield to a vessel with the right-of-way.**
20. **Loading: Distribution—Allowing passengers/gear to be positioned in a way that reduces the stability of the boat, increases the chances of swamping/ capsizing, or obstructs the operator's view.**
21. **Loading: Fuel—Handling fuel in a manner that can cause combustion or spill.**
22. **Loading: Weight—Carrying too many passengers and/or too much gear for the size of the boat, sea conditions and weather.**
23. **Location: Check—Not checking the intended location of operation in advance for hazardous conditions, including rapids, strong currents, waterfalls, low-head dams, or underwater obstructions.**
24. **Location: Hazards—Operating in areas known to be hazardous to the particular type of vessel, including rapids, low-head dams, underwater obstructions, breaking swells.**
25. **Lookout: Ahead—Being distracted and not looking ahead or paying sufficient attention to boats and other obstructions in the intended path.**
26. **Lookout: Course change—Failing to look along the intended path of travel before initiating a turn.**
27. **Lookout: Depth—Underway without visually checking depth of water often enough.**
28. **Lookout: Gear—Failing to look out for swing of the boom or other items of gear that can cause injury.**
29. **Lookout: Night—Not locating/detecting unlighted objects (or flashing marks) in or near the intended course through use of searchlight, binoculars, radar, etc.**
30. **Lookout: Obstructed—Failing to take steps to overcome vision obstructions e.g. sails, boat structures, other boats, passengers, sun glare or spray.**
31. **Lookout: Small objects—Not looking closely for small objects or people in the water where they are likely to be present.**

32. **Lookout: Surveillance—Not exercising all-round surveillance for boats that may be approaching.**

33. **Maintenance: Check fumes—Starting the engine without first operating a bilge blower and sniffing for presence of fuel vapors.**

34. **Maintenance: Controls—Operating with controls (steering, trim plate, throttle, shift, outboard or stern drive trim) in need of repair/adjustment or fitted with wrong replacement parts.**

35. **Maintenance: Engine—Operating with propulsion system that has become unreliable for lack of maintenance (engine doesn't start or stalls, weak battery, power loss, etc).**

36. **Maintenance: Fuel system—Failing to detect leaking fuel distribution lines (engine, stove heating) through periodic inspection /testing.**

37. **Maintenance: Hull—Not making sure the hull is free of leaks or other opportunities for entry of water.**

38. **Maintenance: Lines—Failing to assure that the boat is equipped with serviceable lines (dock, anchor, tow).**

39. **Maintenance: Rigging—Failing to assure proper maintenance of rigging, including shrouds, lines to prevent failure and damage to boat.**

40. **Navigation: Aids—Not using navigational aids adequately to determine position or course relative to shallow water and hazards, including land, jetties, etc.**

41. **Navigation: Current—Failing to account for current in terms of available propulsion, degree of control, and ability.**

42. **No Error**

43. **PFD: Availability—Not having the required number and type of PFDs (e.g. wearable, throwable, and children's) readily available.**

44. **PFD: Non-swimmers—Not requiring occupants unable to swim and exposed to any risk of immersion to wear a PFD.**

45. **PFD: Risk of hypothermia—Not wearing PFD when cold water would jeopardize the chances of remaining afloat.**

46. **PFD: Risk of immersion—Not wearing PFD when conditions create significant risk of immersion, including rapids, dams, rough water, working outside rails, and impaired passengers.**

47. **Protective clothing—Not having or wearing clothing appropriate to the elements, e.g. cold air or water.**

48. **Speed: Maneuvers—Attempting maneuvers at a higher speed than the operator can safely manage, including when approaching another boat, dock or other structure.**

49. **Speed: Obstructions—Operating at too high a speed in close proximity to obstructions, including land, docks, or moored vessels.**

50. **Speed: Other boats—Operating at too high a speed in proximity to other boats, including activities involving games with other PWCs.**

51. **Speed: Reduced visibility—Moving too fast for the limitations of night or other forms of reduced visibility.**

52. **Speed: Turns—Attempting a turn at too high a speed, resulting in loss of control, capsize, or swamping.**

53. **Speed: Waves/wake—Attempting to navigate through waves or wake at too great a speed for wave size.**

54. **Stability: Boat—Committing acts that jeopardize stability and result in capsize, including standing, leaning, reaching or hanging over the side, shifting weight abruptly, not trimming the boat properly for the operation.**

55. **Stability: Occupant—Not keeping a firm grip on the boat; standing in the boat, sitting on seat backs or other locations that invite being thrown off.**

56. **Swimming: Flotation—Not using some form of flotation when entering the water with inadequate swimming ability.**

57. **Swimming: Off/on—Not having a safe method to get off and re-board the boat by those voluntarily entering the water (e.g., to swim or ski).**

58. **Vessel Suitability—Using a vessel with design characteristics (type, length, etc) basically unsuited to the intended operation.**

59. **Waterskiing: Procedures—Towing water skiers, tubes and other devices unsafely or permitting unsafe practices (e.g., wave jumping).**

60. **Waterskiing: Recovery—Not keeping boat clear of skiers in the water in the process of recovery.**

61. **Weather: Ability—Setting out under weather conditions that are beyond the operator's experience.**

62. **Weather: Handling—Not responding appropriately to rough wind/water conditions through safe handling.**

63. **Weather: Operation—Operating in wind and/or wave conditions that are clearly unsafe for the type of boat, including canoes and kayaks, and rowboats.**

64. **Weather: Recognition—Not recognizing conditions that are too severe for safe operation.**

65. **Weather: Security—Not remaining in a secure place aboard in rough weather.**

66. **Weather: Shelter—Not seeking shelter from rough conditions once they become clearly dangerous.**

67. **Weather: Shorten sail—Not shortening or lowering sails when wind conditions warrant.**

68. **Weather: Spill wind—Not watching for gusts and spilling the wind to avoid extreme heel, capsize, or loss of control.**

69. **Weather: Visibility—Not checking forecasts for conditions that make operation unsafe.**

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