

ARTICLES

THEORETICAL AND EMPIRICAL PERSPECTIVES ON MARINE INCIDENTS AND THEIR PREVENTION THROUGH EDUCATION¹

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Abstract

Each year the Government of Canada spends \$220 million on Search and Rescue. The purpose of this paper was to analyze the 35,000 incidents logged by the Canadian Coastguard between 1985 and 1988, to present a model showing factors involved in the initiation and progress of marine incidents and to critically appraise prevention education. *Prevention* education occurs in formal, nonformal and informal settings but its effectiveness is impeded because it is largely preoccupied with technical matters and anchored in an ideology of individualism that does not have sufficient regard for sociocultural factors.

Résumé

Le gouvernement du Canada dépense chaque année \$222 millions sur "Search and Rescue". Le but de l'article était d'analyser les 35,000 incidents inscrits au journal de bord par le "Canadian Coastguard" entre 1985 et 1988, de présenter un modèle qui indique des facteurs impliqués dans l'initiation et le progrès d'incidents marins, et d'évaluer de façon critique l'éducation préventive. L'éducation préventive se trouve dans des situations formelles, non-formelles, et informelles mais son efficacité est limitée car elle se préoccupe en grande mesure de questions techniques et est ancrée dans une idéologie d'individualisme qui fait peu de cas de facteurs socioculturels.

Introduction

A marine incident can be defined as an unexpected and unwelcome occurrence that involves a situation where one or more individuals on a boat—or other marine structure—are in (or are getting into) a situation where they require assistance so as to avoid death, injury, inconvenience or property damage. Search and rescue (SAR) incidents are of two types: *distress*, where the threat of death or serious physical harm exists if aid is not rendered, and *non-distress*,

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where the direct threat of death or physical harm does not exist, but could develop if assistance was not rendered. These incidents cost lives (about 200 a year) and large amounts of money.

The expenditures on marine search and rescue occur because Canada has a long and isolated coastline and there are thousands of incidents every year. Between 1985 and 1988 about 35,000 "incidents" came to the attention of the Canadian Coastguard and nearly half involved vessels in the western region. In addition to the roughly 7000 incidents (groundings, broken down, person overboard, etc.) that come to the attention of the Coastguard each year, many more occur out of sight of the authorities or in places not serviced by the Coastguard. Many are rectified with help from friends, vessels of opportunity, commercial towboats, or salvors. There are also thousands of incidents reported to Coastguard personnel but not logged or forwarded to Rescue Coordination Centres (R.C.C.). Nobody knows how many incidents occur in an average year but it could approximate 100,000. In British Columbia about 200 people drown each year and, according to the Red Cross (1988), boating accidents are the primary cause of drowning in the B.C./Yukon region. In 1987 the number of drownings in B.C. was 2.15 times greater than the national average.

In 1992 almost every Canadian became acutely aware that the Government of Canada spent about \$135 million on a nonbinding referendum concerning the constitution. But in the same year, and in most years previously, the Government of Canada spent nearly twice this amount—approximately \$220 million—on (air, land and marine) search and rescue (SAR). Of the three (air, land, marine) marine incidents represent a considerable drain on public and private funds. For example, the 1990-91 federal estimates for marine SAR in Canada were as follows: National Defence \$120 million; Transport Canada (Coastguard) \$83 million; Fisheries and Oceans \$889,000; RCMP \$347,000. For every one hundred dollars that the Government of Canada spends on SAR *response* it spends only \$1.50 on SAR *prevention* (National Search and Rescue—Part III of the Federal Estimates, 1990-91).

Although less than two percent of expenditures are devoted to *prevention* a 1983 evaluation of Search and Rescue in Canada, coupled with the Report of the **Ocean Ranger** (drilling rig) disaster, along with demands for reductions in public spending, have led to an acceleration of interest in the **prevention** of marine incidents. **Prevention** is normally construed as *regulation* (and enforcement of existing standards) and *education*.

Coastguard *prevention* efforts are mostly focused on courtesy examinations, liaising with and supporting the efforts of organizations like the Red Cross, giving "presentations" and mounting exhibits at boat shows. In 1978 the Coastguard in the Western region devoted seven person-years to prevention. By 1982 this had been reduced to five (person-years), and by January, 1988 there were only two person-years (part-time) involved. By 1991 four person years were being spent on prevention. The integration of the Coastguard fleet had

also spread some of the burden of *prevention* to those whose work had hitherto been confined to servicing navigation aids and suchlike. But, in 1991, there were still insufficient resources to mount an exhibit at the Vancouver boat show (an important setting for informal education). Moreover, the Coastguard has no valid data, derived from experimentation or other dependable research, that attests to the effectiveness of prevention education.

People who drive cars need a license, but anyone in Canada can purchase a boat, turn the key or hoist a sail and head out to sea. There is a strong lobby in Canada that favours operator (as well as vessel) licensing and mandatory continuing education for boaters. There is an equally strong lobby that believes boating safety is best ensured through formal, nonformal and informal education that has adequate regard to the social ecology of boating and boaters.

Issues in Prevention Education

In Western Canada, *prevention* education is mostly couched as “information transmittal” and, in recent years, has been encumbered by staff cutbacks in the Coastguard, the socioculturally differentiated nature of the boating community, an air of desperation in parts of the fishing fleets and the presence of fishing families whose approach to safety is not always amenable to traditional educational methods, techniques and devices (brochures, leaflets, etc.).

Prevention education anchored in a “schooling” model is not congruent with the needs or preferences of significant sectors of the boating community and is rarely informed by principles of adult education. More importantly, there is no evidence to suggest it reaches more than a small percentage of boaters or is based on any sustained study of boaters or boating. At best it is based on vague notions of “creating awareness” or “giving information.”

Agencies

There is no single agency or program that delivers *prevention* education to all types of boat operators. Instead, there is a plethora of agencies and programs that cater to different elements of the boating community, and they operate from contrasting perspectives. *Prevention* education occurs in **formal** (i.e. school and college), **nonformal** (out-of-school) and **informal** settings.

Formal settings include schools, colleges and Marine Training Institutes where largely commercial, or professional mariners study for examinations administered by the Canadian Coastguard.

Nonformal settings include those created by voluntary associations such as the Power and Sail Squadrons, the Red Cross and Coastguard Auxiliary, by the continuing education divisions of school boards and community colleges, by proprietary schools (e.g. sailing schools) and by clubs and boating associations. *Prevention* education that occurs in *informal* settings includes all the serendipitous and incidental education that occurs as a result of reading boating magazines, attending boat shows, and through receiving messages delivered as

part of public education (or communications) campaigns conducted by the Coastguard, boating insurance companies, radio stations and other interested parties.

Barriers

There is nothing technically difficult about action designed to reduce marine incidents. One reason why marine incidents are not a high priority is the fact even people trained to use analytical and rational modes of thought believe they somehow defy systematic study and are due to "chance," "bad luck" or "the weather." Another possible explanation stems from the large number of self-styled "experts" and fatalists ("you can't do anything") in the boating world.

It is also difficult to secure the cooperation of boaters, especially fishers who already feel beleaguered by declining fish stocks and government regulation. Many successful disease control measures did not require active cooperation and caused little inconvenience for those who benefitted. For example, pasteurized milk tastes about the same as non-pasteurized milk, municipal water supplies with fluoride cannot be distinguished from those without. However, when prevention encroaches on what some regard as their "freedom" or when individuals are deprived of their right to engage in culturally sanctioned behaviour (such as boating and drinking), problems occur. Boaters are mostly men who have been conditioned to take risks. Western-style cultures have rewarded the risk taker—whether bull fighter, mountaineer, prize fighter, investor, politician or test pilot—even when risk-taking leads to failure or injury. Prevention measures might call for incorporation of features which prevent incidents (or save lives) but diminish the status of the user. For example, do "real" men need liferafts or Emergency Position Indicating Radio Beacon System Transmitters (EPIRBS)? More importantly, an emphasis on incident reduction or prevention might fly in the face of advertising campaigns that emphasize speed, power and dominance.

These kinds of cultural and sub-cultural factors hinder the acceptance or implementation of safety messages. Psycho-social barriers to prevention require extensive research, but must be considered together with the fact that *prevention* measures sometimes involve threats to industries. For example, certain large boat manufacturers are reluctant to get involved with research about their products which could lead to revelations about construction defects. Editors of boating magazines are in a difficult situation and, with the exception of *Practical Sailor* (a U.S. publication), usually reluctant to identify defective craft because of the fear of litigation. Thus, when construing the notion of prevention, educators or regulators have to consider questions like—Who benefits? Who is in charge here? Who controls this "knowledge" and whose interests are being served?

Epidemiology of Marine Incidents

For many people, marine incidents, even fatalities, are an inevitable corollary of life at sea. Those who make it into retirement are lucky. Fatalism provides

little incentive for prevention; death, injury and property loss are widely regarded as the price to be paid for being on the water. This is in marked contrast to the situation elsewhere. For example, the purification of water, the widespread availability of information about the hazards of smoking, the pasteurization of milk and other advances have led to a reduction in certain types of mortality. But there is no evidence to suggest that marine incidents have decreased. Technological change has meant that one type of incident (exploding boilers in the age of steam) has been replaced by another (gasoline fires in the age of petroleum). Of course some types (such as groundings) remain constant. For example, Galiano in the **Sutil** hit the reef at Canoe Rocks in Porlier Pass in 1791 and in August 1992 a Vancouver teacher in the **Ragus** rolled over on the same rocks. But perhaps the most dramatic incident was in 1792 when George Vancouver nearly lost the **Discovery** when he grounded (and rolled over) near the north end of Vancouver Island.

Various organizations and people in the SAR or boating community gather and evaluate data for their own purposes. Yet there is a marked lack of research that could inform prevention programs, with the exception of the occasional evaluation of some new product—for example survival suits, harnesses, liferafts or flares. Insurance companies study claim patterns and manufacturers test equipment. Probably the most impressive research is done by the Transportation Accident Investigation and Safety Board but this primarily concerns commercial or larger vessels. The Deschenes (1984) study on marine casualty investigation was also noteworthy.

The Coastguard monitors the frequency of incidents that come to their attention. But their database is largely intended to monitor equipment use and, apart from the occasional exception, little of the information becomes part of any public dialogue about boating safety. Even more worrying is that, in times of declining budgets, those who control the most important data could be considered to be in a conflict of interest because the ability to secure resources depends on maintaining a high number of incidents.

Inadequate research easily leads to the adoption of prevention strategies whose adequacy remains untested. There is no shortage of “common-sense” in the SAR community. Yet a lot of programs adopted because of common sense (e.g. handing out pamphlets) fail to withstand critical scrutiny. For example, there is a lobby in SAR circles that claims incidents could be dramatically reduced if authorities would impose boat and operator licensing, mandatory continuing education and heavy penalties for malcreants. But has motor vehicle and driver licensing had a significant impact on motor vehicle incidents (accidents) and why do licensed boat operators still run into the rocks (e.g. **Exxon Valdez**)?

Despite the plethora of organizations conducting prevention education their efforts are hampered by a lack of theory and data concerning marine incidents. Observers might argue that *prevention* education not supported by research “can’t do any harm.” But it can lead to inappropriate emphasis (such as on

boater licensing) and dissipate energy and resources. Inadequately researched prevention measures give the impression that "everything that can be done is being done," when very little is happening. Thus as part of an effort to insinuate an adult education and research focus into discussions concerning boating safety in Western Canada, the author sought to perform an educational "needs analysis" by analyzing marine incidents. It was hoped that this analysis would shed light on the frequency and nature of marine incidents and ultimately shape the character and form of *prevention-education* programs delivered by Coastguard and other personnel.

Incidents Database

The author sought to disentangle variables associated with incidents reported in the Coastguard Marine Incidents database for 1985, 1986, 1987 and 1988. After all the "continuation" lines were eliminated (indicating that a second resource was dispatched) this meant that R.C.C.'s logged 34,436 separate marine incidents in the four years encompassed in the analysis that follows. In 1985 8,138 incidents were logged; in 1986 7,794, in 1987 8,840 incidents and in 1988 9,647.

In view of the fact data gathered "on-scene" is not fed into the Coastguard marine incidents database there is little information that attests to the "cause" of incidents. However, some of the variable relationships reported herein pertain to problems amenable to education.

Of the incidents, 43.00% were in the Western region, 20.20% were in Central Canada, 12.8% in the Laurentian region and 18.00% in the Maritimes. Only 6.00% were in Newfoundland. This should not be interpreted to mean that boaters in Western Canada were more careless or accident-prone than those in other parts of Canada. Although mechanisms exist to monitor the situation, nobody knows how many boats or boaters there are in different parts of Canada, so it was not possible to establish the extent to which the ratio of incidents to boaters varies throughout Canada. Nevertheless, the fact Western Canadian boaters were involved in nearly 13,000 incidents between 1985 and 1988 (and these are only the ones that came to the attention of the R.C.C. in Victoria), shows the magnitude of the problem. It is probable that when all the incidents that do not come to the attention of the Coastguard are added to those entered in the database, there could be up to 100,000 per year in the Western region.

When Incidents Occurred

Most incidents (19.1%) occurred on a Sunday, 18.0% were on a Saturday, and 15.1% on a Monday. The remaining days of the week each had about 11 to 12 percent of the incidents. There are more boaters out in the summer and, as a result, 20.8% of incidents were in July, 19.5% in August and 15.1% in June.

The Red Cross (1988) water safety survey involved interviews with 2,383 small craft users. Only half of those interviewed could name one source of information concerning small craft safety—four percent mentioned the Red

Cross, nine percent the Coastguard and 16 percent identified the Police. About 31 percent said they think of the weather before setting out in a small craft. This survey suggested that many boaters ascribed the same importance to alcoholic beverages as to flotation devices and other safety equipment. The validity of the result concerning alcohol is dubious because responses given over the phone may have little to do with behaviour on a boat. Yet, the result was congruent with the fact the number of incidents "increases" after 7:00 p.m.

Much could be learned from studying the ways in which incidents occurring at different times of the day and night differ. Unfortunately, the variable "time of incident" was treated as a nominal (categorical) variable in the 1985 and 1986 files. In the following two years it was treated as an interval variable—coded in accord with the 24 hour clock. For present purposes it was recoded so as to distinguish day (i.e. from 0600 hours to 1800 hours) from night (1801 hours to 0559 hours) incidents. There are many more boats and boaters out in daylight than at nighttime. Thus the "at-risk" population is greater in daytime. Yet 47.7 percent of incidents (in 1987-1988) occurred at night and only 52.2 percent in the daytime. Almost a third of them occurred after 2000 hours (8 p.m.) at night.

Vessel Types

In the Coastguard files vessels were coded according to type and size and there were codes for sailboards, offshore drilling rigs and open boats. For present purposes this variable was recoded so as to distinguish between six vessel types and "non-vessels." In the four years reported here, 36.1% of incidents involved pleasure/power boats; 15.3% involved sailboats, 26.6% involved fishing boats. Rowing boats and canoes were involved in 1131 incidents (3.8% of the total). Commercial or government vessels were involved in 972 (or 3.2%) incidents.

Variable Relationships

Because there is little emphasis on securing and using on-scene information it is difficult to speculate about the **cause** of incidents. Sometimes the cause has little to do with boat maintenance or the condition of the operator; at other times it resides in cumulative errors or negligence that started long before the vessel left the dock. Moreover, once an incident begins, what started as an inconvenience can develop into a serious situation (as in the **Catch-22** broaching north of Thrasher Rock—see Boshier, 1990). Sometimes there is insufficient evidence concerning the cause of an incident (such as in the **Canadian National No. 5** sinking). All incidents have a life cycle and, as error piles on error, the ultimate cause will often end up being something other than what triggered the incident in the first place. Throughout the summer and on winter weekends the author operates the **Gulftow-99** salvage vessel in Georgia Strait and has seen enough incidents to conclude that what the boat operator does after an incident is "in progress" is, in many cases,

more important than what he/she did to initiate or trigger the situation. Thus, when thinking about **cause** we should remember both the *antecedent* and *trigger* events.

A crude measure of "cause" can be ascertained from reports filed by Coastguard radio operators and R.C.C. controllers. The most startling thing is that the cause of nearly one quarter of the incidents is either not known or not reported. Sometimes this is because a vessel has sunk without trace but usually it is because records kept by personnel assisting the vessel are not read into the marine incidents database that originates at R.C.C.'s. Sometimes the on-scene personnel are from the Coastguard or Coastguard Auxiliary. Other times, particularly in B.C., they are commercial towboat operators, members of community lifeboat societies, good Samaritans from "vessels of convenience," or mariners obliged by law to assist boaters in distress. Little attention can be given to the cause of incidents, particularly in busy times when incidents pile up on each other (such as during the May, 1990 "storm" weekend when Vancouver radio worked 34 incidents in 24 hours).

The data for the four years encompassed by the study appear to suggest that the most frequently occurring incidents ($n = 12,435$, 36.1%) involved mechanical failure, 10.2% were false alarms, 10% involved adrift or derelict vessels, 9.9% were groundings. There were 339 person-overboard situations—a very serious event even in calm seas. The mean wind velocity during incidents was reported to be 10.35 knots (S.D. = 9.02), there were an average of 1.72 persons on board the subject vessels (S.D. = 7.41) and, of the 34,436 incidents, 4337 (or 12.6%) were deemed to constitute **distress**—often involving a Mayday.

Incidents involving pleasure/sail ($X = 2.61$ miles offshore) and pleasure/power ($X = 2.97$ miles offshore) generally occurred closer to shore than those involving government/commercial ($X = 13.14$ miles offshore) or fishing vessels ($X = 12.45$ miles offshore). However, vessels in distress were slightly closer to shore ($X = 5.36$ miles, S.D. = 29.20) than those involved in incidents that did not constitute distress ($X = 6.01$ miles, S.D. = 19.54)

About 200 lives are lost in distress incidents each year. Sometimes several are lost in a single incident (such as in the foundering of the **Canadian National No. 5** in Georgia Strait, February, 1990). A crude index of vulnerability can be obtained by dividing the number of lives lost by the number of incidents experienced by, for example, different vessel types. Thus, of the 1155 incidents involving government vessels, 116 (or 10.04%) involved a loss of life, 10.55% of incidents with open boats involved loss of life as did 8.56% of "non-vessel" (including sailboards), and 3.23% of incidents involving fishboats. Only 50 sailboat incidents involved loss of life (during 9.7% of the sailboat incidents); the 12,566 pleasure/power boat incidents involved 211 (or 1.68%) incidents where lives were lost.

It is tempting to assume that open boats constitute the greatest hazard but without information concerning the number of boats (by type) in use and not involved in incidents we are in no position to make such claims. There are many other variables to consider, for example, the fact 3.10% of incidents occurring on Wednesdays and Saturdays involved loss of life whereas only 1.86% of those on Thursdays and 1.77% of those on Sundays involved loss of life (chi-square 39.79, $df = 6$, $p < .001$).

The **antecedents** and **consequences** of a marine incident involve the conjoint action of many variables. Some of the most crucial reside in the competence of the operator, the condition and age of the equipment and vessel and the nature of the weather. **Consequences** are often determined by the location and proximity to SAR resources.

The *Red Cross Drowning Report* (1989) suggested that most drownings in B.C. occur in the northern part of Vancouver Island. Poor people who have not had access to boating education, are part of the growing flotilla of "non-traditional fishers" (clam diggers, etc.), are under pressure because of pollution and declining fish stocks, and likely to be out in foul weather in an open (and sometimes overloaded) boat. They are clearly in greater jeopardy than the relatively affluent recreational boaters or "traditional" fishers of the Lower Mainland. Additionally, in the southern straits there are more SAR resources, and "vessels of opportunity" are usually closer than in more remote coastal areas. Thus, of the 1492 incidents in the Campbell River/Bella Bella region, 75 (or 5.29 %) involved loss of life. This is in sharp contrast to the situation in the Gulf Islands where 2.19% incidents involved loss of life (e.g. the 1989 diving fatality at Breakwater Island) or the Central Strait of Georgia where only 1.04% of incidents involved loss of life.

A Model of Marine Incidents

Impact of Theory

If other disciplines and problems are a guide, it appears that theorizing about marine incidents could affect *prevention* in several ways. First, broad frames of reference that lie behind theories or models affect the way the problem is construed. For example, to what extent do incidents stem from adverse socioeconomic circumstances? The lack of safety equipment—VHF radios, flares, liferafts, Personal Flotation Devices—also stems from a lack of investment in safety equipment or a lack of access to reasonable supplies. Education construed in this way would show how incidents arise from socioeconomic circumstances.

An observer whose view of marine incidents is *interpretivist* will place great emphasis on the way boat operators construe "safety," "risk," their "masculinity," the "weather" and other attributes of life on the water. The emphasis here would be on a *subjective* view of the world. For example, how do men and women construe "safety," "risk" and "prevention"? There is a

strong suspicion in some quarters that a macho attitude results in situations where people are **aware** of dangers but fail to adopt the appropriate **behaviour**. An approach informed by a *subjective* perspective would be particularly important for new-Canadians who fear “authority,” have learned to distrust government, and do not understand prevention messages in English.

Educators should focus on the way people construe the world differently, and develop educational concepts and processes tailored to the multiple “realities” inhabited by, for example, fishers, pleasure boaters, commercial operators or kayakers. Prevention education construed on this basis would be participatory, conducted in community—rather than institutional—settings, involve “teachers” and “learners” of equal or similar status and designed to empower (even marginalized) boaters to take action to protect themselves. It would also lay stress on gender, power relationships on boats and the extent to which “gender dominance” creates vulnerabilities in person overboard or other perilous situations.

In contrast, an observer who believes there is an objective reality, and that variables are lawfully interrelated, is likely to be less interested in subjective constructions of the world than with technical details of weather, machinery, aids to navigation and boat handling (Boshier, 1990a).

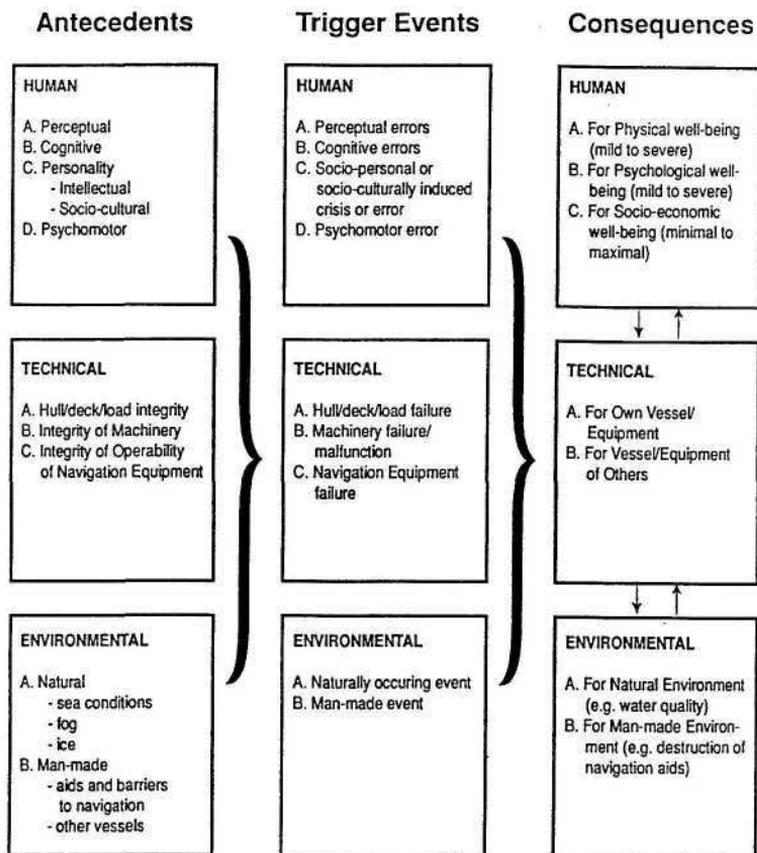
Purpose of a Model

A model is a conceptual analogue used to guide research, policy and, in this instance, *prevention education*. Models influence research but are not usually affected by results. Once a model is selected the researcher does not usually modify it. This is one of the attributes that distinguishes models from theories. Figure 1 shows the components of a model with variables, that in different combinations, represent what happens during most marine incidents. Every vessel has the potential to become involved in an incident. There is no doubt that deferred maintenance, the presence of unsafe equipment or heavy loads, can later combine with bad weather or operator error to produce an incident. Yet it is important to realize that once an incident is “triggered,” what the operator does to control or respond to it has a critical effect on the severity of the situation.

Thus, in Figure 1 there are three components—*antecedents*, *trigger events* and *consequences*. Time goes from left to right and may range from a few seconds (as in an explosion) to many hours (as in a grounding or sinking). In the “real” world of marine incidents it is sometimes difficult to disentangle antecedents from trigger events and consequences since they are often tightly woven as a series of fast-moving events. Moreover it is the variable interactions—between say the *human* and *environmental* variables that are of greatest interest and most amenable to prevention through education.

Although there are grounding “hot spots” (such as Silva Bay’s famous Shipyard Rock—see Boshier, 1985; Boshier, 1989), and persistent technical failures (such as breakdowns in engines, sterndrives, steering and electrical systems) each incident involves a unique combination of antecedents, triggers and consequences.

Figure 1: Model to Explain Antecedents and Consequences of Marine Incidents



Antecedents

Antecedent variables are those that either singly, or in combination with other variables, render a vessel and her crew vulnerable to incidents. By themselves, antecedent variables do not constitute an incident. For example, plenty of people have gone to sea in a leaky boat without incident. But leaky boats, and the presence of other *human, technical and environmental* antecedents create a vulnerability.

Trigger Events

The antecedent variables determine the vulnerability of a crew or vessel. With the onset of a human, technical or environmental trigger event an incident is "in progress." It is the trigger event (human, technical, environmental) which, when added to the existing vulnerability that initiates an incident. Trigger events can be sudden or prolonged. Sometimes the trigger event occurs within the skipper or crew (helmsperson falls asleep, navigator misinterprets a radar or loran, a crew members falls overboard), sometimes it is "technical" (load moves, equipment fails, machinery ceases to function) or "environmental" (fog descends, a squall arrives, a log boom breaks loose). Like environmental antecedents, environmental trigger events are either "naturally occurring" (e.g. fog) or "man-made" (e.g. boom breaking loose). Even women will agree that these are usually man-made.

Trigger events do not have the same effect on all crews and vessels. Their impact depends upon the vulnerability of the crew and vessel. Trigger events almost always arise from the single or combined effects of human, technical and environmental variables. They can be minor (hitting a sandbank) or catastrophic (collision with a freighter).

Consequences

"One thing leads to another" and there is little doubt that what the operator, equipment or "environment" does, once an incident has been triggered, has a considerable influence on its resolution. It often determines if lives are lost and has a significant impact on the expense of rectifying the situation.

In many respects what the crew do once an incident is "in progress" is of even greater significance than the antecedent or trigger variable combinations. Once an incident is "in progress" the crew have little control over environmental variables, but the way in which the human and technical variables manifest themselves can be of immense significance. For example, if a skipper drives a vessel onto a reef, knowing how to stem the flow of water into the hull could be critical.

After incidents have been triggered, the skipper's need to conceal his or her (but usually his) predicament, profound panic or "errors of judgement" can significantly worsen a situation that, if approached from another perspective, could be more easily resolved. Again, it is useful to separate the human from the technical and environmental variables that arise as a *consequence* of a trigger event and thus become part of an incident in-progress.

Model in Action

The way this model can be used to analyze marine incidents and highlight issues pertaining to prevention will now be illustrated by briefly describing what happened during selected marine incidents. For illustrative purposes only one example of each type of incident is reported here. Far more exhaustive analyses are available in the reports of the Canadian

Transportation Accident Investigation and Safety Board (CTAISB) which has had the mandate to investigate marine accidents in Canada since March 29, 1990.

In this summary, the vessel is named and the chief antecedents (A1—human; A2—technical; A3—environmental), trigger events (T1, T2, T3) and consequences (C1, C2, C3) identified.

Human Antecedents Dominant

Chetak. The owner of this sailboat anchored in Nanaimo harbour but, before going to sleep, failed to consult or misconstrued the tide tables (A1). As the tide receded in the early morning hours the vessel grounded. Swift action at this point could have saved the situation but an incident was triggered when the vessel rolled over and took on water (T2). It was later pumped out and refloated with flotation equipment. Although the chief consequences were human (C1) the skipper and the boat were in good shape and continued on their cruising holiday.

Technical Antecedents Dominant

Silver Tide. This 33' gillnetter had left Lasqueti Island in Georgia Strait on August 12, 1990 headed to a gillnet opening at the mouth of the Fraser River. At about 2:30 a.m. on August 13 the seas were getting bigger, and by 5:00 a.m. the stern was down in the water and the skipper felt the vessel had become sluggish. At 5:15 a.m. waves broke over the stern, the skipper glanced at his radar, secured an accurate position, called Mayday and told his daughter to launch their Beaufort 'A'-pack liferaft. Both grabbed survival suits, clambered aboard the raft which deployed properly and awaited rescue by a Coastguard hovercraft. The chief antecedent of this incident was the fact the "stern apron" of this vessel had come away from the hull (A2). As **Silver Tide** banged and crashed into the southerly winds and eight foot seas the gillnetter began taking on water. Thus the primary antecedent was the hull weakness (A2); the incident was triggered by bad weather (environmental variable—T3). The chief consequences were human variables (C1) and, in this case, both skipper and crew acted in an appropriate fashion. Their ability to call a Mayday and give an accurate position greatly enhanced the probability of rescue. The boat was ruined and subsequently burned in a shipyard (C2). In summary, deferred maintenance (A1 and A2) caused the stern apron to come away from the gillnetter which took on water (T2) and was overwhelmed by high seas (T3). Fortunately, the skipper gave an accurate position and safely made it into a raft (C1). This incident was described in more detail elsewhere (Boshier, 1992).

Environmental Antecedents Dominant

Catch-22 was a 30' Philbrooks sloop overwhelmed by big seas (A3) a few miles north of Thrasher Rock. The male skipper, an experienced seaman from the British merchant navy, was unable to control his vessel (A1) and could get

no assistance from his wife (in a wheelchair) or two young children. Lines and sails were washed over the side, fouled his propeller (T2) and placed so much torque on the drive shaft that the diesel engine came off its mounts and was loose in the engine room (T2). This was a well found craft. The chief antecedents were the high seas (environmental—A3); the trigger event was the fouled propeller and loose engine. The chief consequences were “human” (C1). The willingness of the family to go sailing was damaged and, a few years later, the marriage had ended. There is a fuller description of this incident in Boshier (1990).

Using the Model

Although this model was designed to identify factors that explain variance in marine incidents it also has the potential to become a heuristic device for the analysis of other recreational or commercial activities (e.g. skiing, rock climbing, flying and other accidents).

Space constraints here preclude a detailed discussion of all the variables and their various interactions. Moreover, the model needs considerable elaboration. Yet, even at this preliminary stage it evokes numerous issues that ought to be addressed by those involved in prevention education.

This model can be used as a heuristic device to alert educators and learners to the fact incidents often occur because of the conjoint action of several variables. Most importantly, the focus on trigger events and consequences alerts the mariner to the importance of survival, of acting appropriately once an incident is “in progress.” It provides a framework for the organization or analysis of case studies, highlights components that ought to be included in the curricula of boating safety courses and, by giving human and environmental variables the same emphasis as that given to technical matters, rectifies a problem.

Dominance of Technical Matters

At present there is a tendency in Coastguard and other circles to dwell on technical matters, safety equipment, flares and so on. Technical matters are exceedingly important, as are the maintenance of proper navigation and other aids that help boaters deal with currents, rock piles, fog banks, winds and other environmental hazards. But these are relatively easy to deal with compared to the complicated interactions of *human factors* involving perception, learning, motivation and socioculturally acquired ways of construing safety. Flares and P.F.D.'s are significantly less complicated than human foibles.

A corollary of the focus on technical and environmental matters is the notion that human factors are “a constant.” Some educators assume that if boaters have the pertinent information (about flares, etc.) their behaviour will change. But the boating community is highly differentiated and educators cannot assume that people who charter 42' sailboats, or affluent members of yacht

clubs, have the same perceptual and cognitive processes, let alone attitudes and beliefs concerning safety, as those of crabbers, gillnetters and the hundreds of folk who launch 12' aluminium dinghies (with small outboard motors) up and down the coast.

Even the sub-communities within identifiable sectors (e.g. fishing) are highly differentiated. Hence it cannot be assumed that the approach used with seiners will work with gulf-trollers, outside trollers or gillnetters. Quite apart from factors associated with different gear types, educators must also consider the ethnic composition of different parts of the fishing fleet and the fact it is largely a male world.

Cultural Background

The boating community is changing. For example, the large variety of cultural backgrounds possessed by fishers operating out of western ports has created a new challenge (as shown by the problem with asphyxiation and "running" from authorities in the winter of 1988-89), while declining prices and fish stocks (as evidenced by the "disappearance" of fish in the 1992 season) are tempting fishers to take more risks. Fishers are also prone to claim that lives will always be lost in B.C. waters until someone changes the weather. Unfortunately, the pressure on fish stocks is causing fishers to go into rougher waters than previously and educators should be careful not to habitually "blame the victim" for incidents.

Making Changes

The cause of an incident often resides in structural factors that leave the individual boater with limited options and an inability to exercise "choice." For example, concerning the sociocultural antecedents (Figure 1) there are two "realities" concerning ethnic relations in Canada which have considerable relevance in this context. One claims that Canada is an equitable society and no one ethnic group dominates the others. Those holding this view think Canada is a "level playing field" and expect immigrants to "fit in." If they fail to do so, there is a tendency to "blame the victim." The second view is that Canadian society is structured so as to systematically discriminate against people on the basis of gender, race, or class. These structures are entrenched by a covert ideology of racism. Most boaters have heard the excruciating discussions that occur on VHF Channel 16 when fishers whose first language is something other than English attempt to secure assistance from the Coastguard. Coastguard radio operators do not appear to speak languages other than English and certain commercial tow operators are unwilling to service fishers from some ethnic groups.

Quite apart from implications that racist ideology has for SAR-response these factors also create a formidable challenge for prevention. It does not suffice to simply translate "safety pamphlets" into languages other than English. Much more needs to be said about this but, in this context, it suffices to note that immigrant or First Nations fishers constitute just two of many groups in

the boating community and further point to the need for a *differentiated* approach that has regard to human (including sociocultural) as well as technical and environmental matters. Prevention education is not just a rational/technical process of delivering information but one deeply embedded in the sociocultural, political and economic contexts of the many boating communities in Canada.

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