Visibility Factors in Small Boat Collisions

Bartley J. Eckhardt, P.E. (M); William J. Vigilante, Ph.D. (V); Peter F. Coste, P.E., CFEI (V)

This study examined powered craft operators’ ability to identify a kayak under differing visibility conditions. The kayaker was either wearing a dark PFD or a fluorescent shirt over the PFD, and positioned against a water or land background. Results indicate that the background the kayak is seen against affects identification distance regardless of garment worn. Also, the paddle flash was consistently noticed first, regardless of background or shirt condition, although the fluorescent shirt helped participants identify the object as a kayak. Identification distance and its effect on boater safety and education are discussed in the context of avoiding collisions with very small craft.

KEY WORDS: Education; collision/accident; maneuvering; forensic; marine accident reconstruction; operations (general); research; safety; small craft; MWC; manual powered water craft.

INTRODUCTION
Collisions between manual powered water craft (MWC) and sail or powered craft (SPC) are a serious concern for professional mariners and recreational boaters alike. USCG statistics show that in recent years, collisions with a recreational vessel have consistently ranked as the leading primary marine accident type. Operator inattention and improper lookout are leading primary contributing factors to marine accidents.

Human factor considerations including the visibility conspicuity, detection and identification of manual powered water craft (MWC), weigh heavily in marine accident investigations and forensic analysis of collisions. A PWC (personal water craft) that is idle or disabled in the water will act similarly as an MWC.
Oftentimes, seconds or less in power craft response can make the difference between a catastrophic collision and a harrowing but harmless near miss. For the operator of an SPC to take evasive action to avoid a collision, they must first detect and then identify the presence of the MWC. Visual detection and identification distance is critical in providing the SPC operator with sufficient time and distance to alter their course or take appropriate emergency action to avoid colliding with a MWC.

This research study, using groups of boaters and non-boaters, examined identification distance and the effect of conspicuity enhancing treatments and background on the ability to detect and identify MWC. Participants, blind to the presence and location of a kayak on the Chesapeake Bay, were driven toward a kayaker and asked to respond when they identified a small non-powered vessel that can cause them to alter course or take evasive action to avoid a collision.

The study established a baseline for reasonably attentive lookouts.

For each trial, the target kayaker wore a dark red and black personal flotation device (PFD) or a fluorescent tee shirt over their PFD and was positioned either against a land background or a water background. The distance at which each participant identified the kayak as a condition that they would need to take actions to avoid was recorded.

METHOD
Design
This experiment was a 2 (background) x 2 (shirt) between subjects factorial design. Identification distance to a target kayak was measured for each participant.

Participants
Fifty-six volunteers participated in this experiment. Participants were either self-selected from the Elkton/Elk Neck, MD and Del-Mar peninsula areas or volunteers from Robson Forensic, Inc. (RFI). RFI is a forensic engineering firm with offices across the United States and headquartered in Lancaster, PA. All RFI volunteers were based in the Lancaster, PA office. The RFI volunteers were a mix of personnel from our technical and administrative staff. The non-Robson Forensic participants responded to advertisements in local newspapers. Upon concluding their participation, all volunteers were provided with a small gift bag which included a $25.00 gift certificate to a local business. Participants were also provided with a full explanation regarding the study’s purpose, and asked to refrain from informing other potential participants about the study until its completion.

Vessels
The target was a 17 foot long ocean going yellow sea kayak captained by a seasoned open water kayaker. The kayaker either wore a dark red and black PFD or a fluorescent tee shirt over the PFD (see Photos 1 and 2). The kayaker controlled and paddled the kayak with a 7 1/2 foot long symmetrical double paddle with white blades. The kayaker was provided with an audible warning device, a marine band VHF-FM transceiver for communication, and a handheld Garmin® GPSmap 76Cx waterproof geographic positioning system (GPS) receiver.

A 19 foot long pontoon boat powered by a 40 horsepower outboard motor was used as the observation vessel. The boat was captained by an experienced ex-Navy officer and manned with a first mate tasked with observing and recording the data. A bench with room for four participants sitting side by side was installed across the bow of the boat. The boat’s pilot station was located behind the participant bench. The boat’s canopy was erected for all runs. Participants used a simple two-position electronic handheld switch tethered to a two state (on/off) LED display aft of the pilot station to indicate identification distance. Photo 3 depicts the boat and the observation setup.
runs with the kayak. The GPS system was used by the first mate to record boat positions during the study. The first mate was stationed behind the pilot station and was responsible for monitoring the switch display and recording each participant’s identification distances based upon the GPS position.

Photo 3. Observation boat.

Location
The experimental runs were conducted along the Elk River near North East, Maryland (see front page). The pontoon boat was launched from a launch ramp in Elk Neck State Park. The experimental runs were made in the daytime during the week and during periods of light water traffic. During the land background condition, the kayak was positioned at the northeast end of the Elk River Channel. During the open water condition, the kayak was positioned about 1,700 yards south of Turkey Point near buoy #7.

The experimental runs were conducted on July 18, July 19, August 11 and October 7, 2011. During each run, the weather was clear, with no precipitation or unusually choppy water.

Materials
An instruction sheet was created along with a waiver and background questionnaire. The instruction sheet provided participants with consistent instructions. (See Appendix A) The waiver and release that each participant read and signed is attached as Appendix B

To obtain background information for each participant, a survey consisting of three sets of questions was constructed. The first set of questions asked participants for the following demographic information: age, gender, ethnic background, and the highest level of education completed. The second set of questions asked the participant if they (a) were color blind or had trouble distinguishing colors, and (b) had any vision problems or problems seeing distant objects. Participants were asked to respond by either circling “Yes” or “No.”

The third set of questions was intended to capture participants driving and boating experience. Participants were asked to indicate “how often do you drive a motor vehicle/car” and “how often do you operate or captain a boat or vessel” using nine point Likert type scales anchored with: 1=never; 3=rarely; 5=occasionally; 7=frequently; 9=very frequently.

Participants were also asked to respond “Yes” or “No” to the following question: Do you or have you ever own/ed a powered/motored boat? If participants answered “Yes,” they were asked to check all of the following that apply: fishing, pontoon, speed, yacht, and other (please specify).

Participants were also asked to respond “Yes” or “No” to the following question: Do you or have you ever own/ed a non-powered vessel? If participants answered “Yes,” they were asked to check all of the following that apply: canoe, kayak, paddle boat, row boat, sail boat, and other (please specify).

Procedure
Each day, prior to the arrival of any participants, the pontoon boat carried the kayak to one of the two locations previously selected for the background. The kayak was launched, the position of the kayak was logged into the GPS unit as a waypoint, and the boat returned to pick up the participants.

Participants were given two hour time slots in groups of four, with the first group scheduled to sail at 10:00 AM. When the participants arrived, they were provided the waiver and background questionnaire to complete. A number was randomly assigned to each participant, determining their seat assignment onboard the boat, and used to match their data and forms.

Upon seating each group aboard the pontoon boat, each participant received a PFD and an identification switch. The group was then briefed on the exercise. Participants also received a copy of the instruction sheet while the boat captain explained that once he announced the beginning of the exercise, they were to act as if they were the boat operator, and as such they were required to avoid collisions. Of special importance, they were to keep a lookout for small non-powered vessels such as canoes, rowboats, kayaks or rafts that were likely to be in or crossing their path of travel. Participants were instructed that if they identified a small non-powered vessel either in or likely to be in their path of travel which could create a potential collision hazard, they would need to maneuver the boat and should toggle their handheld switch. The participants were instructed to disregard debris in the water, as well as jet skis, sailboats and powerboats, as well as boats at anchor. Participants were also instructed that it was not a race to see who saw something first. Further, they were not to alert others when they identified a target that fit the objective of the exercise.

During the briefing, participants were also instructed on how to use the handheld switch to indicate if they identified a target that met the exercise criteria. The switches were tested by the
participants before leaving the pier to ensure they understood what action to take when they saw a target and to ensure the switches worked.

As the pontoon boat approached the location where the kayak was positioned, the first mate watched the four signal lights that would be activated by the participants. As each light came on, the first mate would enter a waypoint into the GPS and log the number of the participant. When all participants had indicated that they saw the target, they were asked what had attracted their attention while the first mate recorded their verbal responses. When the pontoon boat came alongside the kayak at the end of each run, a waypoint was entered into the GPS to log the intercept position of the kayak. Latitude and longitude data for each waypoint were plotted to determine the range at which the kayak was identified.

Once the pontoon boat reached the kayak, it reversed course and motored back to the boat launch. At the end of the study, the participants were briefed as to the nature of the study and asked not to inform potential participants regarding the details and purpose of the study. Once the pontoon boat arrived back at the boat launch, the participants were assisted onto the dock, thanked for their time and provided with gift bags.

RESULTS

Demographics
The participants in this study were of an average age of 49.4 years old (SD=16 years) and 46% were female. Eleven percent of the respondents reported having a high school diploma; 36.5% had some college level education or a technical school degree; 28.5% had a college degree, and 23% had at least some graduate level education. All participants were Caucasian. Only one of the participants reported being color blind or had trouble distinguishing colors. Five of the participants reported having a vision problem or a problem seeing distant objects (which were corrected with glasses or contact lenses). Sixty-six percent of the participants were wearing sun glasses.

Prior Experience
Fifty-five of the participants reported driving a motor vehicle frequently or very frequently; one participant reported rarely driving a motor vehicle \((M = 8.7, SD = 0.9)\). Table 1 presents the number of participants who responded to each of the nine options provided for the question: How often do you operate or captain a boat or vessel? \((M = 2.7, SD = 2.2)\)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Never</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3 Rarely</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5 Occasionally</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7 Frequently</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>9 Very Frequently</td>
<td>2</td>
</tr>
</tbody>
</table>

Fifty-seven percent of the participants reported owning or having owned a boat with 94% and 56% owning or having owned a non-powered and powered boat, respectively. Table 2 presents the participants’ responses with respect to the type of vessel owned or currently owned.

<table>
<thead>
<tr>
<th>Powered vessel</th>
<th>Count</th>
<th>Non-powered vessel</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing</td>
<td>15</td>
<td>Canoe</td>
<td>21</td>
</tr>
<tr>
<td>Pontoon</td>
<td>1</td>
<td>Kayak</td>
<td>19</td>
</tr>
<tr>
<td>Speed</td>
<td>4</td>
<td>Paddleboat</td>
<td>6</td>
</tr>
<tr>
<td>Yacht</td>
<td>2</td>
<td>Rowboat</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>Sailboat</td>
<td>6</td>
</tr>
<tr>
<td>(jon boat)</td>
<td></td>
<td>Other</td>
<td>2 (raft)</td>
</tr>
</tbody>
</table>

First Noticed
At the end of each run, participants were asked about the first thing they noticed that drew their attention to the presence and location of the kayak. Over 76% of the participants reported first noticing the paddle flash from the kayaker who was controlling the position of the kayak. One participant reported noticing the water splash from the kayak first, while another participant reported first noticing the kayak itself.

In the fluorescent shirt condition, 25% of the participants reported first noticing the shirt and then the paddle flash; while a little over 14% of the participants reported noticing the paddle flash first and then the fluorescent shirt. Many of the participants in the fluorescent shirt condition stated that the presence of the fluorescent shirt helped them identify the object they saw as kayaker (boater), as opposed to debris in the water. Photos 4 and 5 depict the white paddle flash and the aid which the fluorescent shirt provides in identifying the target as a kayak, as opposed to debris in the water.
The two-way Analysis of Variance (ANOVA) was used to examine the effect of background and the presence or absence of a fluorescent shirt on identification distance. Several three-way ANOVAs were then conducted to examine the added effects of gender, boat ownership, and sunglasses on the identification distance. Due to the unequal cell sizes, Least Square (LS) Means were used in all of the three-way ANOVAs, and Type III sums of squares were computed to determine their significant main effects and interactions. All significant ANOVAs were followed by Fisher’s Least Significant Differences (LSD) tests to determine if cell means differed significantly from one another using a two-tailed alpha level of .05. All distances are given in yards. One nautical mile (NM) = 2025 yards.

Identification Distances
A two-way Analysis of Variance (ANOVA) was used to examine the effect of background and the presence or absence of a fluorescent shirt on identification distance. Several three-way ANOVAs were then conducted to examine the added effects of gender, boat ownership, and sunglasses on the identification distance. Due to the unequal cell sizes, Least Square (LS) Means were used in all of the three-way ANOVAs, and Type III sums of squares were computed to determine their significant main effects and interactions. All significant ANOVAs were followed by Fisher’s Least Significant Differences (LSD) tests to determine if cell means differed significantly from one another using a two-tailed alpha level of .05. All distances are given in yards. One nautical mile (NM) = 2025 yards.

The 2 (background) X 2 (Shirt) ANOVA on identification distance showed a significant main effect for background, \( F(1,52) = 5.73, p = 0.020 \), but not shirt. Paired comparisons among the background conditions indicated that participants were able to identify the kayak at greater distances when viewed against the shore (\( M = 601.2, SD = 198.9 \)) than open water (\( M = 483.3, SD = 155.4 \)). Although the main effect for shirt was not significant, in general, participants were able to identify the kayak at a greater distance when the kayaker was wearing a fluorescent shirt over his PFD (\( M = 565.5, SD = 190.2 \)) than no shirt (\( M = 515.4, SD = 182.3 \)). There was no significant background X shirt interaction.

There were no significant main effects for gender, the use of sunglasses, prior boating experience, or the type of boat owned. Table 3 provides the Means and Standard Deviations for each of these four variables. There were also no two or three way interactions involving these four variables with the background and shirt conditions.

Table 3. Means and Standard Deviations for other variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>567.6</td>
<td>189.8</td>
<td>Owned PV</td>
<td>566.7</td>
<td>193.4</td>
</tr>
<tr>
<td>Female</td>
<td>512.9</td>
<td>182.0</td>
<td>Never Owned PV</td>
<td>530.6</td>
<td>184.7</td>
</tr>
<tr>
<td>Sunglasses</td>
<td>572.4</td>
<td>197.0</td>
<td>Owned NPV</td>
<td>557.1</td>
<td>193.4</td>
</tr>
<tr>
<td>No Sunglasses</td>
<td>483.5</td>
<td>152.5</td>
<td>Never owned NPV</td>
<td>525.0</td>
<td>180.5</td>
</tr>
<tr>
<td>Operated vessel</td>
<td>559.7</td>
<td>188.3</td>
<td>Never operated NPV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never operated vessel</td>
<td>519.0</td>
<td>185.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*PV = powered vessel;  
**NPV = non-powered vessel

DISCUSSION

The Perspective of the Small Unpowered Craft
This study revealed typical identification distances of a very small manual powered water craft (MWC) in the range of about \( \frac{1}{4} \) nautical miles (NM) (506 yards). As closing distance shortens, it is not unusual for the operator of a MWC to be able to see the bow of an approaching sail or powered craft (SPC), as well as its registration numbers, but not be able to see the operator or occupants of the vessel. The ability to see the SPC operator is dependent upon the size the vessel, how high the bow of the SPC is above the water when it is on plane, location of the SPC operator on the vessel, and the distance to the SPC.

One method to gauge a potential collision is to take a relative bearing to the approaching SPC at frequent intervals using the “bow angle” method. Kayakers for example, are instructed to use their paddle to point toward a vessel they believe to be on a closing and possible collision course. Completed at 30 second to two minute intervals, this method affords an approximation of relative bearing. Consistent relative bearings suggest the two
vessels are on a collision course. This is especially valid where MWC encounters commercial vessels. The MWC operator may observe the ship or tug/tow at the prevailing visibility distance, often two to five NM. Such commercial vessels are likely moving at speeds below 20 knots, and the MWC has ample opportunity to change course to avoid a collision.

However, problems occur when MWC encounter faster moving SPC. With typical identification distances of the MWC in the range of ¼ NM and SPC speeds often between 20 and 60 knots, it is practically impossible for the MWC to maneuver its way out of a collision. At an SPC closing speed of 30 knots, an extremis condition occurs within 30 seconds, and this is under the idealized conditions of this study.

The current study revealed that the MWC viewed against a shore background, affords the SPC operator an additional 15% (greater than 100 yards) identification distance when compared to an open water background. A conspicuity enhancing fluorescent shirt affords the SPC operator an additional 7% and approximately 50 yards identification distance. An SPC closing speed of 30 knots, the shore background can yield an additional six seconds and the fluorescent shirt an extra three seconds in identification time and corresponding distance. The extra time provided by the increased visibility of MWC can make the difference between a collision and a harrowing near miss.

Collision avoidance in such a circumstance is predicated on the SPC having a proper and attentive lookout posted. Generally study participants’ first saw “paddle flash” – reflection of the wetted white surfaces of the paddle between strokes. The fluorescent shirt of the paddler allowed study participants to more quickly identify the paddler following the visual cue of the paddle flash. There is no equivalent to “paddle flash” for very small craft that are idle in the water or for swimmers.

Audible signaling devices such as marine whistles and air horns can have effective ranges of up to one NM. The occupant of the MWC typically does not and cannot know if they are seen by an approaching SPC. The MWC operator has little option but to do all they can to make their presence known. This includes, for example, purposely waving and “flashing paddles” and sounding an audible signal. However, the MWC operator must recognize that the audible signal could be drowned out on the SPC by its engine noise. Furthermore, the MWC operator must be using a paddle with white or light color blades to benefit from the affects of the paddle flash (i.e., darker blades do not reflect light in the manner of lighter colored blades).

The actions of the MWC operator are sensitive to timing. This study reveals that at separation distances beyond approximately one half NM, such measures would be largely ineffective. The ability for a motor boater to link audible and visual signals to pinpoint the source as the MWC occurs within the ¼ NM range. For many circumstances, this already constitutes an “in extremis” situation. Therefore, the MWC should take any and all measures possible, and without hesitation, to make their presence known when they feel threatened by craft bearing down on them.

**Zones of Vulnerability**

For the following discussion, Zones of Vulnerability are defined as any location or condition in which a MWC is likely to be detected too late for the approaching craft to avoid a collision. The current study reveals three types of Zones of Vulnerability, described as follows:

**Type I Unmasking**

With typical identification distances in the range of ¼ NM, there are many circumstances in which a MWC can be suddenly revealed to an SPC, similar to a pedestrian “darting out” between parked cars and into oncoming vehicle traffic. Such circumstances occur when the MWC is obscured by: Peninsulas; Islands; Larger Craft; Blind Bends; Piers; and Docks.

Prudent course planning by the MWC can avert unreasonable vulnerabilities. Based on the results of this study, the MWC is better detected against a land background; however, there is a point where traversing too close to shore can place the MWC into a Zone of Vulnerability. An example is shown below:

**Type II Channel Crossings and Land-to-Land Transits**

There are conditions when crossing channels and affecting land-to-land transits where the MWC would take so long to cross that it could find itself in a Zone of Vulnerability. This is described in the following graph:
**Type II Zone**

If \( t_{SPC} \leq t_{MWC} \) then a Type II Zone of Vulnerability is established.

For example, assume the visibility is 2000 yards and a MWC travelling at 1.5 knots is attempting to cross a 1500 yard wide channel. When the MWC embarks across the channel, nothing is visible. A tug/tow appears travelling at 4 knots. Although the MWC may believe they are safe, the tug/tow will reach them before they are across the channel. With \( \frac{1}{4} \) NM identification distance, the tug/tow will not be able to stop or maneuver in time to avoid a collision.

**Type III Obscured by Environment**

Any existing conditions that mask key identification features of the MWC will negatively affect identification distances. Most participants identified paddle flash as the first visual cue. Therefore, wave conditions, white caps, and frequent wave reflections can mask paddle flash. Furthermore, the use of dark colored paddle blades result in less reflection from the sun thereby reducing the beneficial effects of paddle flash on detection and identification distance. In addition, the ability to identify a MWC over open water, which reduces identification distance compared to a land background, is made more difficult when the MWC is between the approaching SPC and the sun.

**Recommended Actions for MWC**

The following eleven recommendations provide MWC operators with a greater likelihood of avoiding a collision with a SPC, and are suggested for inclusion in boater safety and education:

1. Carry required safety equipment including audible signaling devices;
2. Wear fluorescent attire;
3. Hug shoreline except where you can be quickly unmasked;
4. Preserve maximum sight lines;
5. Understand implications of your speed, the speed of other vessels, time and distance to shorten your exposure and minimize collision risk;
6. Maintain a visible presence through paddle flash;
7. Use paddles with white or light colored blades (e.g., yellow);
8. Cross perpendicular to traffic when crossing a channel;
9. Be cognizant of prevailing SPC traffic; put yourself where powerboats are less likely to be;
10. Be mindful of and do not place yourself in Zones of Vulnerability; and
11. Do not hesitate in using simultaneous audible and visual signaling to make your presence known to approaching powerboats.

**The Perspective of the Sail or Powered Craft**

The operator of an SPC is obligated to maintain a proper lookout. Often the prevailing weather or water conditions challenge even seasoned SPC operators when sailing in the vicinity of MWCs. The sun angle, the sea state, vessel traffic and the presence of flotsam add to the difficulty of identifying very small craft such as kayaks.

In this study, the approach to the kayak’s position began at about 4,000 yards. The approach speed was 10 knots. This gave the participants ample time to become accustomed to the motion of the boat and practice at being a lookout. They were expecting to potentially see a target, and every participant did identify the kayak.

Large ships and tugs in tow will be using the marked channel, and are generally easier to see and avoid. In general, however, a small MWC may appear suddenly in the path of the SPC. The importance of the lookout is emphasized in the Zones of Vulnerability.

The second factor is related to speed. The faster the SPC travels, the less time the operator has to detect, identify, and respond in the event of suddenly identifying a MWC. Not only must the lookout be alert, but the operator must be prepared for the unexpected. In the area where the study was conducted there were numerous crab pot markers as well as large logs that had to be avoided, as well as other distractions. Hitting a log at any speed can ruin a good day on the water. Hitting a MWC is devastating.

**Recommended Actions for SPCs:**

SPC operators should be educated about the following nine factors that affect the likelihood of avoiding a collision with a MWC:

1. At 30 knots, a power boat has 30 seconds to react to the presence of a MWC at the average identification range;
2. The SPC operator must keep an alert and proper lookout. This includes listening for audible signaling devices;
3. SPC operators need to be aware of the MWC Zones of Vulnerability;
4. Increasing speed decreases reaction time;
5. Be aware of the value of sunglasses and binoculars;
6. Environmental conditions may require extra vigilance; sun glare can hide MWCs or mask the paddle flash;
7. Expect the unexpected;
8. Do not let activities such as stowing gear, hauling in fenders, tending lines to be a distraction; and
9. The use of alcohol slows reaction time and hinders detection and identification distance.

CONCLUSION
This study evaluated identification distances of very small craft. The study revealed that:

1. Average identification distance under idealized conditions is approximately ¼ NM.
2. Identification distance is enhanced when the very small craft is viewed against a shore background and when wearing fluorescent attire.
3. There are Zones of Vulnerability that prudent operation of very small craft and power and sail craft must be aware of and avoid.
4. Twenty recommendations are made with regard to boater safety and education to help commercial and recreational mariners avoid collisions with very small craft.

ACKNOWLEDGEMENTS
The authors of the study would like to recognize and thank our first mate, Bret Johnson, our editor and scheduler, Kathleen Herman for all their assistance, time, and input. The study would not have gotten off the ground and completed on time without their help and efforts. We would also like to extend our thanks to Wendy Gilbert at the Cecil Whig for writing about our study and its impact on boater safety.

REFERENCES
1. Sea Kayaking Safety & Rescue, by Lull, John (2001), pg. 170

APPENDIXES
Appendix A
Thank you for participating in our boat study.

During today’s study, we would like you to pretend that you are an operator/driver of a motor-powered boat. As the operator, it is your responsibility to avoid colliding with other boats and vessels that are on the water.

Some boats and vessels are easily identified from a distance, such as large sail boats and fishing boats, cargo ships and barges, tugboats towing barges, and larger powered boats and speed boats. The ability to identify these types of boats from a distance provides operators with the ability to easily avoid them.

However, it is often more difficult to identify smaller vessels, such as jet skis and SeaDoos, row boats, canoes, kayaks, and rafts that may be in your path of travel or are likely to cross your path of travel.

During our study, the experimenters will be operating this boat in a straight line or path across the water. When we are far enough off shore, you will be instructed by the experimenter to start. At that point in time, your job is to observe the water in front of and to the sides of the front of the boat and identify any small non-powered vessel (for example, row boats, canoes, kayaks, and/or rafts) that may be: a) in the path of our boat, or b) likely to cross the path of our boat. If you identify a small non-powered vessel, press the button on the paddle given to you but do not point, yell out, or otherwise alert your neighbors that you have identified such a vessel.

Also, please note that you may see channel markers (buoys) as we travel. These are fixed in position, are not a hazard, and should take care not to mistakenly identify them as a small non-powered vessel by inadvertently press your button.

Please let us know if you have any questions or concerns.

Thank you again for participating in our study.

Appendix B
WAIVER, RELEASE AND INDEMNIFICATION AGREEMENT
I, the undersigned participant (“Participant”), for myself and on behalf of my next of kin, heirs, personal representatives, successors and assigns, for and in consideration of the opportunity to participate in the boat safety/boat visibility study (the “Study”) being conducted by Robson Forensic, Inc. (the “Company”) and for other good and valuable consideration, receipt of which is hereby acknowledged, and intending to be legally bound, do hereby agree as follows:

I HEREBY ASSUME ALL KNOWN AND UNKNOWN RISKS. I am aware that participating in the Study presents a risk of personal injury, death and damage to or loss of personal property which may result from the wide range of activities and conditions which might possibly be undertaken, performed or encountered during the Study, including without limitation: boarding and de-boarding watercraft; adverse weather conditions such as rain, sleet, extreme heat or cold or lightning storms; adverse water conditions; travel on or over unfamiliar and/or uneven waters, terrain, artificial and natural obstructions; and/or standing and/or sitting for prolonged periods of time. I
am voluntarily participating in the Study and I assume and accept any and all risks of injury, death or damage to or loss of personal property, including those injuries or damages resulting from acts or omissions of the Company, its owners, directors, officers, agents, employees and affiliates (collectively, the “Released Parties”).

I HEREBY RELEASE, FOREVER DISCHARGE AND HOLD HARMLESS the Released Parties, individually and collectively, from all actions, claims, demands or liability of any kind that I, my heirs, executors, guardians, legal representatives and assigns have or may hereafter have for damage to or loss of personal property, personal injury or death resulting from, arising out of, or in connection with, my participation in the Study, even if such actions, claims, demands or liability result partially or wholly from negligent and/or intentional acts or omissions of any of the Released Parties. I UNDERSTAND THAT THIS MEANS THAT I AGREE NOT TO SUE ANY OR ALL OF THE RELEASED PARTIES FOR ANY INJURY RESULTING TO MYSELF OR MY PROPERTY ARISING FROM, OR IN CONNECTION WITH, MY PARTICIPATION IN THE STUDY.

I AGREE TO INDEMNIFY, DEFEND AND HOLD HARMLESS the Released Parties, individually and collectively, against any and all claims, suits, demands, liability, judgments, losses, costs and expenses (including without limitation reasonable attorneys' fees and litigation costs) incurred by any of the Released Parties arising out of my participation in the Study, including without limitation the enforcement of this Waiver, Release and Indemnification Agreement (this “Waiver”).

THIS WAIVER SHALL BE construed and interpreted in accordance with, and controlled by, the laws of the Commonwealth of Pennsylvania, without regard to its rules regarding choice-of-law.

THIS WAIVER IS INTENDED TO BE as broad and inclusive as permitted by law, and if any portion or provision is held to be invalid, void, or unenforceable, I agree that the remaining portions or provisions shall remain valid and enforceable.

By voluntarily signing this Waiver, I certify that I have read the Waiver and fully understand it and that I am not relying on any statements or representations made by the Released Parties. By signing this Waiver, I further certify that I understand I am waiving certain substantial legal rights that I, my heirs, next of kin, executors, administrators, assigns and representatives may have.

CAUTION: READ BEFORE SIGNING. THIS IS A

RELEASE

Participant Name: ____________________________

Participant Signature: __________________________

If Participant is under the age of eighteen (18), this Waiver and Release must be signed by a parent or legal guardian of Participant.

Parent/Guardian Name: __________________________

Parent/Guardian Signature: __________________________