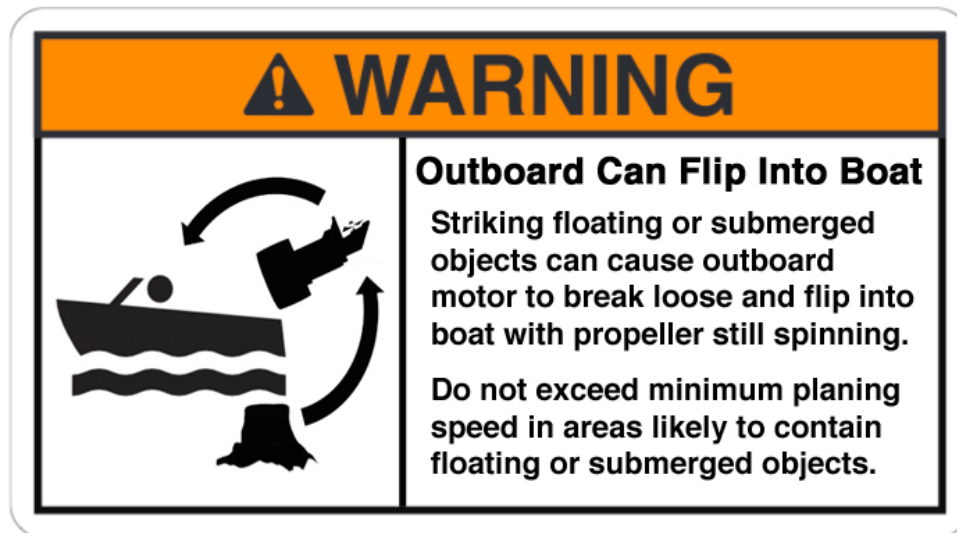


Why Outboards Used in Bass Tournaments Disproportionately Break Off & Flip into Boats Compared to Other Outboard Motors



**This paper is for stimulating discussion on this issue,
it is NOT professional advice.**

27 February 2019

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PropellerSafety.com**

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Introduction

Outboard motors have been breaking off and flipping into boats for at least six decades. In the absence of any efforts to collect data on these accidents, they were long overlooked. Few boaters were aware this was even possible.

The U.S. Coast Guard's Boating Accident Report Database (BARD) does not include a specific category for outboard motors breaking off and flipping into boats. Without a specific BARD category for these accidents, researchers are left trying to find them in BARD redacted narratives¹ (brief written stories about what happened) and other sources.

USCG first released redacted narratives with 1998 BARD. As time passed it became obvious from media reports, BARD, and legal cases that several large outboard motor flipped into the boat accidents involved bass boats, and more specifically, bass boats used in tournament fishing.

By the 2000s many bass fisherman were hanging around popular online fishing forums. When an outboard motor would break off and flip into a boat, sometimes someone would post something about the accident or those injured or killed. Others bass anglers began to chime in with similar experiences. Still others marveled about how an outboard motor could enter a boat or doubted that it happened at all.

In February 2012 we published the first online list of outboard motors breaking off and flipping into boats. That list quickly grew as our research spread to historical news coverage and older BARD data.

In June 2014 we published a second list of these accidents online. The second list focused on large outboard motors breaking off and flipping into boats.

With many of the more recent accidents being on bass boats and more specifically on bass boats used in tournament fishing, we thought it was time to explain why bass boats are disproportionately involved in these accidents.

This paper explains how Bass Tournament Conditions, Boat & Outboard Motor Manufacturers, and the Business of Bass Tournaments all come together to produce modern bass tournaments. Boat & Outboard Motor Manufacturers and the Business of Bass Tournaments have unintentionally brought together the conditions necessary for outboard motors to break off boats, some of which will enter the boat. This unintended consequence has spread over time from fully decked out tournament bass boats during tournaments, to practice fishing, and now down toward entry level bass boats. See **Figure 22** at the close of this paper.

For those unfamiliar with the process by which outboard motors can break off and flip into / enter boats, please see Appendix I.

¹ USCG BARD redacted narratives are verbal descriptions of what happened in reported boating accidents meeting certain criteria less any private information.

What Are the Risk Factors?

USCG BARD redacted narratives and State accident reports in which a large outboard motor broke off and flipped into the boat were reviewed, along with media reports, personal accounts, and legal cases. Some related technical papers were reviewed as well. Six groups of risk factors were identified from these accidents.

1. **Components:** high horsepower outboard motor (>100 Horsepower), hydraulic log strike system, jack plate, even more recently boats powered by outboards targeting bass tournament anglers such as Mercury Pro XS and Yamaha VMAX SHO. Swivel brackets, jack plates, and occasionally older transoms fail allowing the outboard to break free.
2. **Operating Conditions:** underway at speed, fishing tournament, practicing for fishing tournament, more time on the water at speed, covering lots of water (distance)
3. **Object:** stump, large log, floating tree, large floating debris, cement, fixed object, dredge pipe, unknown object
4. **Boat Operator:** 100 percent male, may not extremely familiar with this particular lake, may be operating a relatively new boat, on the water for many hours (boater fatigue), sense of haste such as in a bass tournament, some experience at operating a boat in excess of 50 mph, alcohol is not a factor in these accidents. Accident report may list cause as, "Excessive speed" and/or "No proper lookout" and/or "Inattentive".
5. **Boat Design:** bass boat style boat, boat designed for speed, powerhead of outboard motor mounted high with respect to gunnel with nothing in front of it (like on bass boats or center consoles), outboard motor with vertical center of gravity near the gunnel (less height to clear), seated operator (limits vision of floating or submerged debris). People seated up in the middle of the boat (in the area the outboard falls), facing forward (they cannot see the outboard coming at them). Center console boats are sometimes involved. Numerous cables, lines and controls to the outboard continue to remain attached after it breaks off (they direct the path of the outboard in flight). Battery cables in particular tend to remain attached.
6. **Water Characteristics:** shallow water, areas with stumps, large floating debris, rough water (harder to see floating objects plus rough water itself can cause this failure), dredge pipes in the area

Not all these conditions are of equal weight, velocity and the presence of large debris or fixed objects are the most critical variables. If an outboard is going fast enough and strikes a large piece of debris or fixed object, the outboard motor may break off and flip into the boat.

Most of the other variables have to do with the debris being harder to see, increased exposure (covering lots of distance on the water), and being easier for the outboard motor to enter the boat if it does break off.

Bass Tournament Conditions

Conditions present in bass tournaments will now be discussed including:

1. Presence of many of the risk factors previously identified
2. The Quest for Speed
3. Obstacles in the Water
4. Shallow Water & Poor Visibility
5. Invisibility of Submerged Objects
6. Extensive Practice Fishing
7. Boater Fatigue

The Risk Factors Are Present in Bass Tournaments

While the frequency of these accidents is unknown, about 45 are identified on our list of large outboard motors flipping into boats since 1999. Boats built by bass boat builders are highlighted in yellow.

If you read the list of **Components, Operating Conditions, Object, Boat Operator, Boat Design, Water Characteristics** in the previous section, they basically describe conditions present in bass tournaments.

Several of these risk factors have been present in accidents in which smaller outboard motors flipped into boats for decades. However, it is tournament bass fishing that built a popular activity around the intersection of these risk factors.

Tournament bass fishing has drawn tens of thousands of boaters to an activity where many of these risk factors are present. Most pro bass anglers and several advanced amateurs are aware of the hazard of outboard motors breaking off and flipping into boats. However, bass tournament organizations, bass boat manufacturers, and some outboard motor manufacturers have yet to publicly recognize the hazard. As a result, thousands of amateur bass anglers are unknowingly exposed to this hazard.

Bass tournaments feature a “blast off” start with anglers being released a few seconds apart one after another. Tournament anglers try to get to their favorite fishing hole first, sometimes traversing very long distances. When fishing becomes less productive, they quickly move from one fishing hole to the next. Time spent traveling is time not spent fishing, so tournament anglers try to get to the next location as fast as possible. At the end of the day, anglers race back to weigh in with their 5 largest bass just before the deadline.

Outdoor journalists have long pointed out the hazards of bass boats hitting submerged objects at high speed. Zack Taylor’s 1974 Sports Afield article,² The Incredible Dangers of Bass Boating, was only one of several such articles published in the 1970s.

Shallow water is fished so frequently, fully equipped bass boats typically feature two shallow water anchors mounted to the transom (Power Poles).

The Quest for Speed

Figure 1, 2, 3, 5 and 20 represent Yamaha and Mercury Marine’s attitude toward bass boat speeds.

The image in **Figure 1** was screen captured from Yamaha’s website in January 2014 .

See the Big water = big air photos of anglers in 2016 Bassmaster Classic on Bassmaster for additional images.

² The Incredible Dangers of Bass Boating: Don’t Die for a Bass. Zack Taylor. Sports Afield. August 1974.

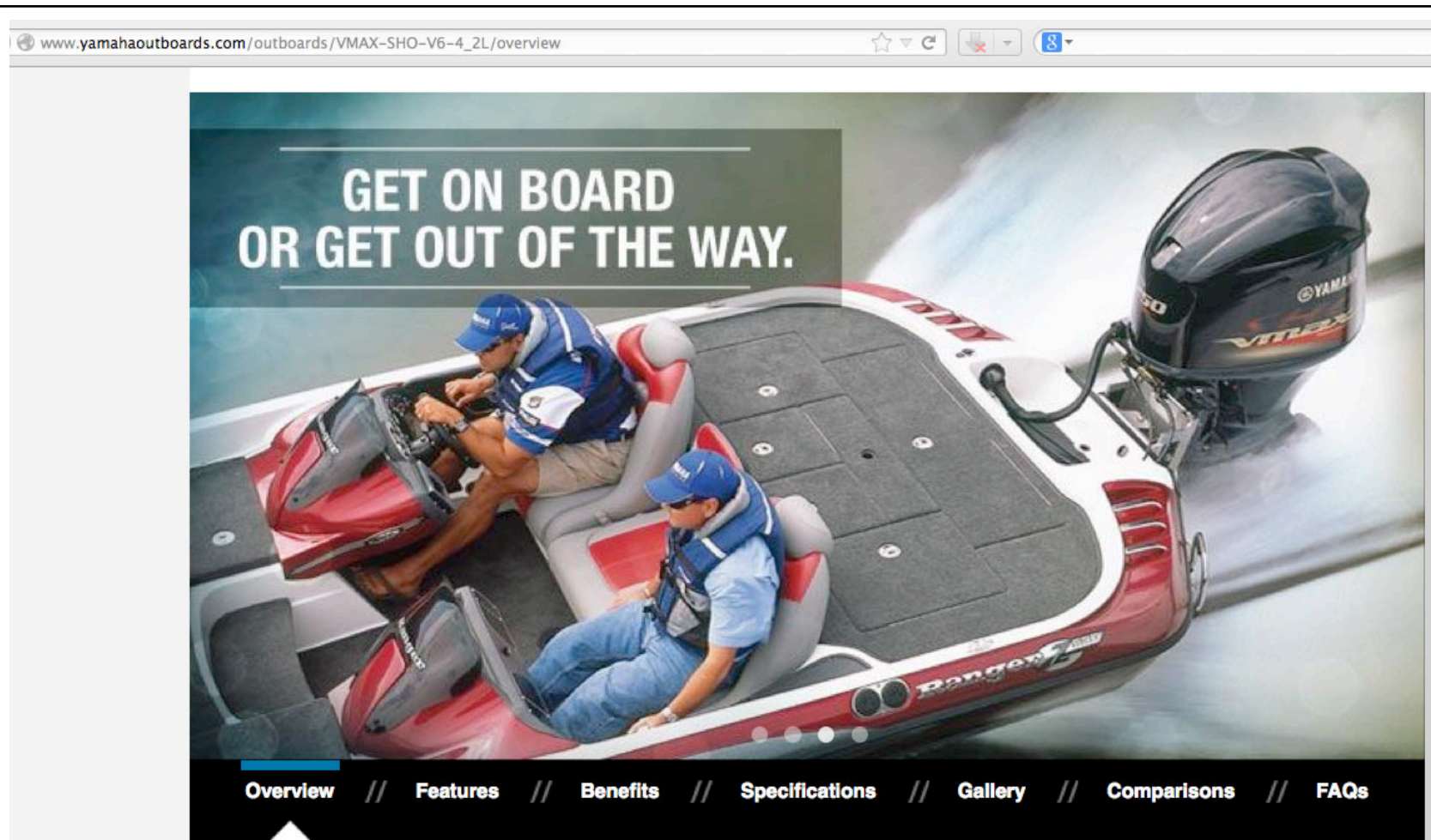


Figure 1: Get on Board or Get Out of the Way
Yamaha marketing image 2014



Figure 2: VMAX SHO Images from Yamaha 2009-2010 Interactive Media Kit

Get the choice of champions behind you.

The tournament-proven, direct-injected **Mercury® OptiMax® Pro XS™** gets you to the fish first, lets you fish longer, and gets you to the weigh-in on time. That's the power of the fastest engine on the water. For outstanding acceleration and top speed, nothing beats it. That's why more pros want Mercury behind them. Including back-to-back FLW Tour Anglers of the Year. Mercury behind you, the world before you. Visit your Mercury Dealer or mercurymarine.com.



©Mercury Marine

Figure 3: Mercury Pro XS outboard behind a Ranger bass boat
current promotional image

Obstacles in the Water

“Pro Fishing’s Pit Crews”,³ a 2013 BassMaster article discusses the abuse pros put their equipment through to get to bass. The article focuses on Bassmasters TV coverage of the 2013 Alabama River Elite tournament. At that event Tommy Biffle destroyed the lower unit of his outboard and had to be rescued.

As to shallow water, the Bassmaster article says:

“With so much riding on the results, our boats become nothing more than a means to reach the fish. Trees, shoals and other boats aren't the only obstacles we encounter. When the water's high and the fish are back in the woods, you can bet the pros will follow them. They'll use their boats like all-terrain vehicles, grinding up flooded brush as if it were soft milfoil.”

The article opened with the image shown in **Figure 4** of Mike Iaconelli, a Yamaha pro, in the trees.



**Figure 4: Mike Iaconelli, Yamaha pro, in the trees at a 2013 Sabine River tournament with his VMAX SHO outboard.
Bassmaster image**

“Ike” later said he was moving along pretty good when he hit something in the water. He guesses it was a partially submerged log. He lost control, the boat veered to one side, and ended up on the bank as seen in **Figure 4**.⁴

³ Pro Fishing’s Pit Crews. Bernie Schultz. Bassmaster. 14 August 2013.

⁴ The Sabine Was Tough - in More Ways Than One. Michael Iaconelli. Bassmaster. 18 March 2013.

The image of Mike Iaconelli's boat in **Figure 4** is similar to a more recent image of Alton Jones' boat in the sticks in a 10 June 2018 online Bassmaster article⁵ during the 2018 Bass Pro Shops Bassmaster Elite also on the Sabine River.

Shallow water increases the probability of striking floating or submerged objects. Shallow water may be traversed at high speeds to get to fishing holes as shown in the Yamaha promotional image on Facebook shown in **Figure 5**.

Anglers often travel considerable distances from their homes to fishing tournaments. Pre-fishing opportunities are limited. As a result, anglers may not have knowledge of submerged hazards known to locals.

Even if you know where some fixed objects are, tides, rains, storms, and mankind continuously bring new floating debris to deltas, rivers, streams, and lakes.

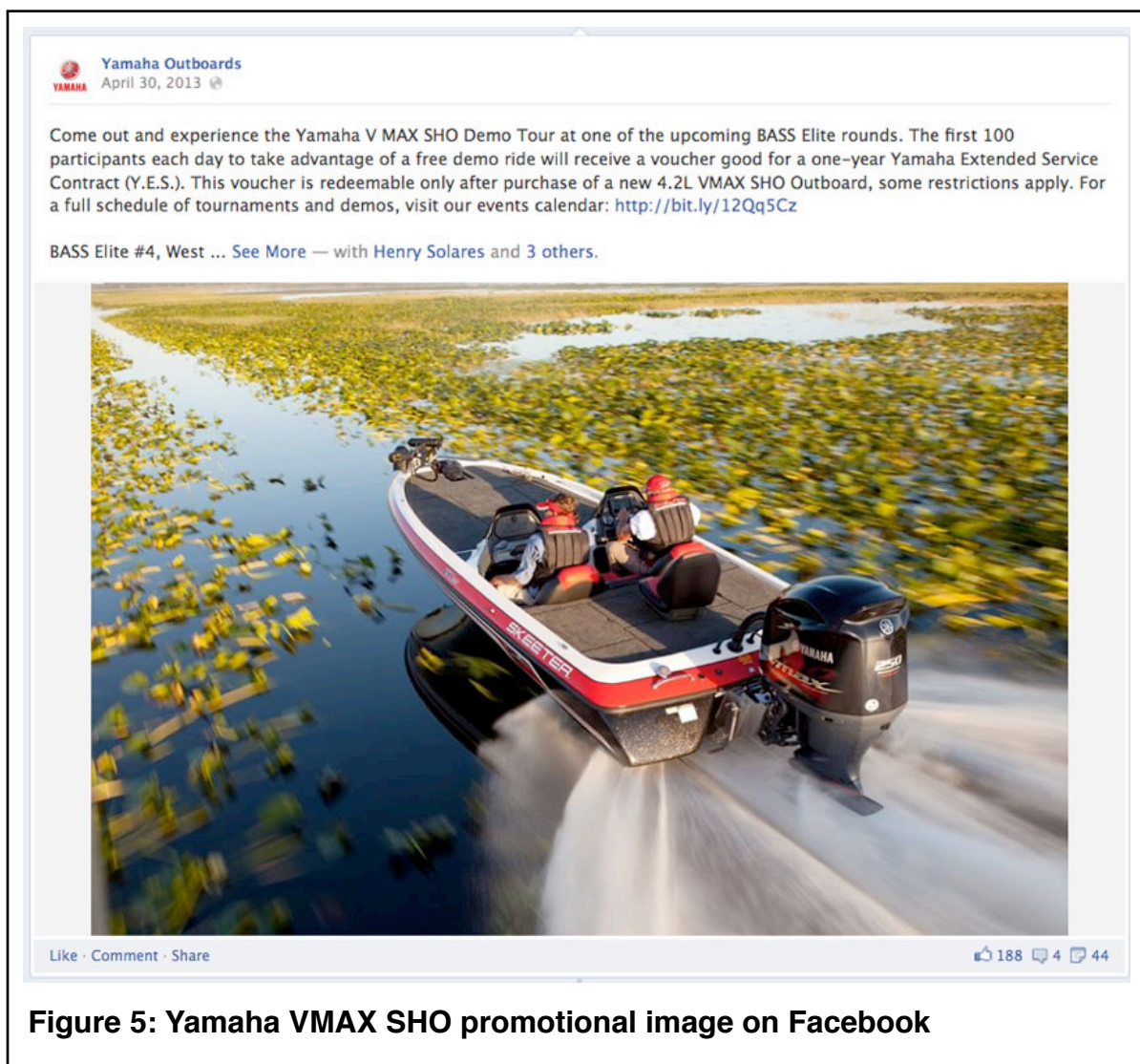
Back in the 1960s the U.S. Navy mathematically proved the wider a submerged hydrofoil is and the more distance it goes travels in areas with floating debris, the more likely it is to strike floating debris. Basically, a hydrofoil sweeps an area and the more area you sweep, the more likely you are to strike something.⁶ The same goes for bass boats. If you are running in areas thought to contain floating debris or shallow fixed objects, the more miles you cover, the more likely you will strike something.

⁵ Jones and his Marshall uninjured in boating accident. Bassmaster. 10 June 2018.

⁶ A Method for Predicting the Probable Number and Severity of Collisions Between Foilborne Craft and Floating Debris. Nathan K. Bales. Structural Mechanics Library. Research and Development Report. David Taylor Model Basin. Department of Navy. August 1963. Report 1723.

Shallow Water & Poor Visibility

Yamaha and Mercury Marine both show outboards running at speed in shallow water conditions with poor visibility in their promotional materials. See **Figure 5** and **Figure 6**.





Shaw Grisby Demonstrates the Durability of the Mercury Pro XS

Mercury Marine
Subscribe 5,158

5,998 views

Download Add to Share More

Published on Jan 28, 2013
Shaw Grisby, host of One More Cast, shows the durability of the Mercury Pro XS by running his boat through a grassy lake. The Pro XS has a superior cooling system design unparalleled to the competition. See for yourself, right here.

Figure 6: Shallow Water Running of Mercury Pro XS
Mercury YouTube Channel
 video published 28 January 2013

Mercury's video in **Figure 6** features the boat operator stating that with the Mercury Pro XS outboard, "we can run through this heavy stuff where air boats run."

Invisibility of Submerged Objects

Accidents in which a large outboard motor strikes a submerged object, breaks off, and flips into the boat almost always results from striking an object the operator and his or her lookout did not see, or did not see in time to avoid.

The invisibility of many submerged hazards to boat operators underway precludes the taking of evasive action to prevent striking them. For example, dredge pipes floating just at the surface are often struck.

As to the invisibility of submerged fixed objects struck by boats, a 1992 U.S. Coast Guard funded study conducted by Underwriters Laboratories found:

“Chapter 4 showed that many of the objects struck in CWF XO (Collision With Fixed Object) accidents are not seen prior to the impact. Stumps and underwater rocks are examples. These are particularly dangerous, in part, due to the surprise factor. The operator almost never has a chance to see the stump before the impact, precluding the opportunity for any evasive action. As a result, neither the operator nor any of the occupants are prepared for an impact, and may be more easily thrown off balance or thrown overboard.”⁷

The study went on to note,

“Almost all the impacts with an underwater object will be considered as “boat ran over the top of the object.”⁸

When bass boats are underway above planning speed (when the boat rises up to reduce drag) little of the hull extends below the water. When they strike fixed underwater objects and pass over them at planning speeds, the bottom of the hull may be scraped or even punctured by the object, but the outboard motor typically takes the brunt of the collision because it extends deeper into the water.

⁷ Recreational Boat Collision Accident Research. Volume 1. Underwriters Laboratories. Sponsored by a U.S. Coast Guard Grant. October 1992. Page 9-14.

⁸ Recreational Boat Collision Accident Research. Volume 1. Underwriters Laboratories. Sponsored by a U.S. Coast Guard Grant. October 1992. Page 4-22.

Extensive Practice Fishing

Many bass tournaments have a few days practice fishing in front of the tournament allowing anglers from a distance to become accustomed to the lake and current bass behavior. Top pro anglers fish all year. Spring rains, seasonal changing water levels, storms, tides, droughts, and water releases through dams make it more likely anglers will strike hidden objects. Some pro anglers spend 200 plus days a year on the water, covering thousands of miles on the water making it almost a certain they will strike floating and/or fixed objects at speed.

Boater Fatigue

Boater fatigue refers to dulling of the senses caused by prolonged exposure to sun, heat, wind, vibration, noise, waves, and the motion of a boat. Boater fatigue is also known as boater's hypnosis.

Boater fatigue makes it harder for the operator to recognize a floating or submerged object at speed. Making matters even worse, boater fatigue even slows down the operator's reaction time if they do see a floating or submerged object.

As to inattentiveness, anglers are heavily focused on trying to catch "keeper" fish. Bass tournament anglers are often out on the water several hours a day for multiple days. In a 2006 interview, Brian Westfall, outreach ranger for the U.S. Army Corps of Engineers (USACE) said, boat operators should be aware of "boater's fatigue" that can set in during the late afternoon after a day on the water. The condition cuts down on the driver's concentration and may cause him to miss dangers in the water including swimmers and other boaters.⁹

U.S. Army Corps of Engineers National Water Safety Program Safety Tips includes this comment:

*"Research shows that four hours of boating, exposure to noise, vibration, sun, glare and wind produces fatigue that makes you act as if you were legally intoxicated."*¹⁰

U.S. Coast Guard Visual Alertness Stressor Test (VAST) studies in the 1970s found boater fatigue could slow response times by almost two seconds.¹¹ VAST studies also found exposure to noise (including wind noise) slowed down response times of fatigued boaters in some instances.¹²

⁹ Accidents Injure Three Persons at DeGray Sunday. The Daily Siftings Herald (Arkansas). 3 July 2006.

¹⁰ Safety Tips. National Water Safety Program. U.S. Army Corps of Engineers. Viewed January 11, 2014.

¹¹ Recreational Boat Safety Collision Research. Phase I Volume 1 - Problems Definition. Final Report. CG-D-143-75. United States Coast Guard. Department of Transportation. September 1975. Pgs. 85-86.

¹² Noise Effects on Boat Operator Performance. Report No. CG-D-23-78. Final Report. United States Coast Guard. U.S. Department of Transportation. January 1978. Pgs. 54-55.

Leisure

This section explores the science of leisure, the study of serious leisure, and their relationship to modern day bass tournaments and bass anglers.

Of particular note is a 1995 thesis on the Commodification of Serious Leisure featuring a case study of Bass Tournaments.

Science of Leisure

The Serious Leisure Perspective (SLP) on SeriousLeisure.Net defines:

Leisure: *un-coerced, contextually framed activity engaged in during free time, which people want to do and, using their abilities and resources, actually do in either a satisfying or a fulfilling way (or both).*

Serious leisure: *the systematic pursuit of an amateur, hobbyist, or volunteer core activity that is highly substantial, interesting, and fulfilling and where, in the typical case, participants find a career in acquiring and expressing a combination of its (1) **special skills**, (2) **knowledge**, and (3) **experience**¹³. The adjective "serious" embodies such qualities as earnestness, sincerity, importance, and carefulness. This adjective, basically a folk term, signals the importance of these three types of activity in the everyday lives of participants, in that pursuing the three eventually engenders deep self-fulfillment.*

Robert A. Stebbins, now of Canada, laid the groundwork for the academic study of serious leisure in the 1970s. Tournament fishing obviously fits into the serious leisure category.

Some Serious Leisure Activities Are Driven by Commodity Agents

In 1995, Daniel G. Yoder built upon Stebbins work on serious leisure with "Tournament Bass Fishing: Commodification in a Serious Leisure Activity."¹⁴

Yoder notes the interrelationships between equipment manufacturers, professionals, competitions, and amateurs in certain commodity (equipment) intensive leisure activities such as tournament bass fishing.

Yoder refers to the strong dependence of a leisure activity on equipment and significant interplay of manufacturers within the activity as the commodification of sport.

He goes on to express his belief that without all the high tech fishing gear, it is unlikely tournament bass fishing would exist in its current form (see last quote on next page).

¹³ Note these three items were not numbered in the original quote.

¹⁴ Tournament Bass Fishing: Commodification in a Serious Leisure Activity. Daniel G. Yoder. University of Illinois at Urbana-Champaign. PhD thesis. 1995.

A portion of the abstract of Yoder's thesis is below:

"The preponderance of high-tech fishing commodities in tournament bass fishing calls attention to the diverse uses and meanings individuals and groups have for their possessions. Commodities in this setting are potent social symbols whose purchase, possession and exchange convey to owners and others a myriad of diverse meanings. Commodities contribute to self and group identity, to growth through the acquisition of skills and knowledge and to the development and maintenance of a social world built around a unique ethos. Some tournament bass fishermen also use boats and equipment to display status and purchase power. In addition, producers and distributors of fishing commodities are shown to create as well as respond to demand.

This research offers a revised model of serious leisure for commodity intensive activities that recognizes the role of commodities and the individuals and groups that facilitate their use. Stebbins' model of serious leisure includes the three organizational groups of professionals, amateurs and publics. However, the revised model containing three new organizational groups - commodity agents, professionals/commodity agents and amateurs/publics - offers a more complete understanding of some serious leisure activities."

With respect to commodity agents, Yoder says:

"Commodity agents are essential to the understanding of tournament bass fishing because the activity is heavily dependent on purchased goods and services. This commodity dependence is especially noteworthy in light of the perceived simplicity of the act of fishing. Without high tech-bass fishing equipment and services, it is unlikely that the sport could exist in its current form. Groups and individuals have responded to, nurtured, and, in some cases created, a demand for fishing boats, tackle, electronic equipment, services, and the competitive formats essential to the sport."

The Business of Bass Tournaments

Bass Tournaments are big business. Many players are represented including anglers, pro anglers, sponsors, tournament organizations, retailers, communities, equipment manufacturers, media outlets, and more.

This section elaborates on the commodification of bass tournaments as introduced by Yoder in the previous section.

Three books are recommended for those wishing further study of the business of bass tournaments:

1. Bass Wars.¹⁵
2. Bass Madness.¹⁶
3. The Fish That Changed America.¹⁷

¹⁵ Bass Wars: A Story of Fishing Fame and Fortune. NickTaylor. 1988.

¹⁶ Bass Madness: Bigmouths, Big Money, and Big Dreams at the Bassmaster Classic. Ken Schultz. 2006.

¹⁷ The Fish That Changed America: True Stories About the People Who Made Largemouth Bass Fishing and All American Sport. Steve Price. 2014.

The Commodification of Bass Tournaments

Today's bass tournaments strongly exhibit commodification as described by Yoder.

When Ray Scott launched modern bass tournaments in the late 1960s and later launched Bass Anglers Sportsman Society (B.A.S.S.), manufacturers of products used in bass fishing were not far behind. Makers of outboard motors, bass boats, depth finders & fish finders, fishing tackle, trolling motors, and many more accessories quickly saw the advantage of being associated with bass tournaments. Prize money grew and manufacturers began to associate themselves with these events and specifically with well known anglers to increase their marketing footprint.

As tournaments continued to grow and TV (ESPN) began covering major tournaments, prize money continued to grow and product sales increased. ESPN owned the major organization, B.A.S.S., from 2001 - 2010.

As the industry grew, product innovation exploded. Bass tournaments took a very basic activity, catching fish, and turned it into a commodity driven activity with dozens of flashy high tech "must have" products and gadgets, some in product categories that did not exist a few years ago.

New products developed or improved in the bass tournament era include: economical GPS units for the consumer marine environment, navigational systems, side scan sonar, power poles, foot throttles, hydraulic jack plates, trim & jack plate toggle controls on the steering column, light weight high tech outboard motors, foot controlled trolling motors, smart trolling motors, fishing lures of all types, high tech rods and reels, Hydrowave, high tech fishing line, larger more powerful outboards, onboard live wells, onboard storage lockers, large onboard computer displays you can see in daylight, windshields on consoles, special deep cycle marine batteries, high-tech battery chargers, integrated "smart" electronic systems for boats, boat wraps, Power Poles, and inflatable life jackets. The almost constant stream of new products continues today.

Turmoil in Paradise

A recent [New York Times article](#)¹⁸, discussed the status of the bass tournament business, pro anglers, tournament organizations, and sponsors. The article announces the defection of many top anglers from Bassmaster events to a new Bass Pro series of tournaments ran by Major League Fishing (MLF).

B.A.S.S., MLF, and FLW (Fishing League Worldwide) were in a war for the most talented bass anglers. MLF appears to have won the battle for 2019 anglers.

¹⁸ This is the Most Lucrative Moment in History to Catch Bass. Harley Cohen Gilliland. New York Times. 18 October 2018.

The Evolving Structure of Bass Tournaments

Tournament structure evolved into using your own boat, catch & release, quickly spaced blast off starts, large purses of dollars boats & gear, weigh in extravaganzas, points being awarded during the year, ending with league championships including the Bassmaster Elites and the Bassmaster Classic. The FLW tour, the Elites, and the Classic feature large outdoor Expo Halls providing manufacturers yet another place to showcase their wares. Pro anglers not making the cut at major tournaments can be seen working their sponsor's booths at the Expo and signing autographs.

Bass tournaments made significant safety statements years ago when they began requiring anglers to wear life jackets when underway and again in 1973 when B.A.S.S. began requiring tournament boat operators to attach kill switch lanyards after the death of Vernon Fowlkes in Bassmaster Classic III. Other tournament organizations gradually followed their lead.

Early information about MLF's new Bass Pro series suggest some changes to the basic structure of bass tournaments will be coming such as weighing in all the fish you catch above a given size at the time of catch, then immediately releasing them. The winner being the angler with the most total pounds caught above the size limit, not just the 5 top bass. It remains to be seen what MLF's plans are for any sort of ceremony similar to traditional weigh ins. Instead, the new MLF Bass Pro series will focus on live coverage online of the event itself, supplemented with some delayed TV coverage.

The Relationship Between Pro Anglers and Their Sponsors

Over time, a symbiotic relationship has developed between pro bass anglers and their sponsors (they need each other). Pro anglers need money and the best equipment to be able to fish all year to hone their skills. Sponsors need pros to hype their products. See **Figure 7**.

Some wishing to break into the pro ranks think all they have to do is catch a lot of big fish to secure sponsors. Seasoned sponsors know its not all about catching big fish, it is also about interacting with individual and crowds while marketing their products, including an ability and a platform of existing followers such as a Facebook page to keep their product or service in the press while keeping themselves out of trouble.

In todays time, many pro anglers are paid or partially paid with their sponsor's products which they turn around and resell to middlemen or lower tier anglers. Sponsorship means a range of things to different sponsors from discounts on their products, to free products, to actually being paid in products or dollars.

Sponsors can be endemic (manufacturers of products heavily associated with bass fishing) such as bass boats, outboard motors, and fishing rods & reels. Some sponsors are non-endemic (products, services, or organizations not directly associated with catching bass) such as Miracle-Ear, Toyota Trucks, and Carhartt clothing.



Some outboard motor manufacturers actually have their own pro fishing team. Jared Miller shown in **Figure 7** is one of several pro bass anglers from the State of Oklahoma. He is part of Yamaha's pro fishing team.

The Economics of Bass Tournaments

The bass tournament industry is economically fueled in part by:

1. Several solid, well established major bass tournament organizations (with some current turmoil among them)
2. Hundreds of local and regional bass organizations and sponsors hosting thousands of tournaments annually
3. The Bassmaster Elite Series and the Bassmaster Classic, the FLW series sponsored by Wal-Mart, and the recently launched Bass Pro series by Major League Fishing (MLF)
4. The relationship between pro anglers, serious amateurs (rising through the ranks and influencing others), and sponsors
5. Some pro anglers operate small businesses selling their own fishing products & services (such as their own fishing lures or being a fishing guide). Their success on the circuit increases their name recognition and their sales.
6. The media (TV money, bassmaster.com, Bassmaster Media, Bassmaster magazine, MLF)
7. Internet money has quickly grown with some anglers constantly being followed by their own camera crew feeding their own Internet channels.
8. Major prizes (like boats) donated by manufacturers for marketing purposes
9. Major retailers devoting shelf space to bass fishing gear
10. Fans, "wantabe" pros, and everyday bass fishermen buying bass fishing products
11. Tournament bass fishing at the top levels is a very physically demanding sport. However, it is viewed as being more of a mental sport than a physical sport. This makes it easier for armchair fishermen to imagine themselves as pro anglers resulting in even more customers for bass fishing media and products.
12. Similarly, the activity is definitely not limited to those under 35 years of age like many professional sports. This also increases the number of armchair pro anglers consuming bass fishing media and products.
13. With tournaments held around the United States, more people have the opportunity to rub elbows with pro anglers creating more interest in the sport
14. Manufacturers providing a constant stream of new products, especially high tech products

15. Several well known personalities not all of which are currently tournament anglers
16. Bass Pro (stores, Tracker, Nitro, Ranger, Triton, Cabellas, sponsor tournaments)
17. Keeping tournaments family friendly (the entire family comes out)
18. Countless bait shops and small retailers
19. Entry fees for major events can be as high as a few thousand dollars per angler.
Bassmaster's 2018 Elite Series annual entry fee was just shy of \$50,000. These fees were substantially lowered or basically rebated in 2019 for anglers that fished the Elite series in 2018. Major League Fishing's tournament has provided BASS some very stiff competition for pro anglers.
20. Cities paying to host major tournaments for the economic boost major events bring to their region
21. Lakeside communities welcoming anglers and their fans to local hotels, motels, fuel stops, diners, restaurants, and more.
22. Expo Halls rent space and services to vendors and sponsors from which they sell their wares and services

Figures 8 through 12 provide an indication of the level of corporate involvement in the sport.



Figure 8: Yamaha and Mercury Compounds at the 2016 Bassmaster Classic

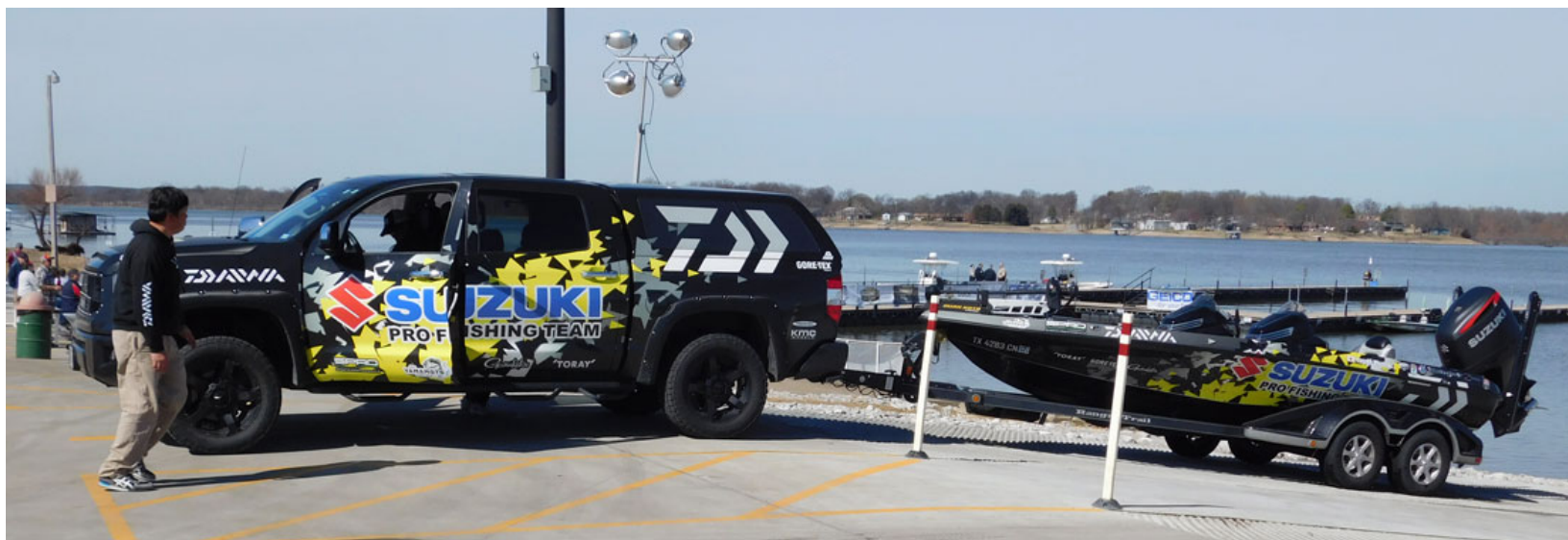


Figure 9: An Angler Sponsored by Suzuki at the 2016 Bassmaster Classic



Figure 10: Greg Hackney and Others Awaiting Trailers at the 2016 Bassmaster Classic. Note commercials on the colorful boat “wraps”.



Figure 11: Mercury powered angler loading out at 2016 Bassmaster Classic. Note full use of advertising space on the boat “wrap” and other surfaces.

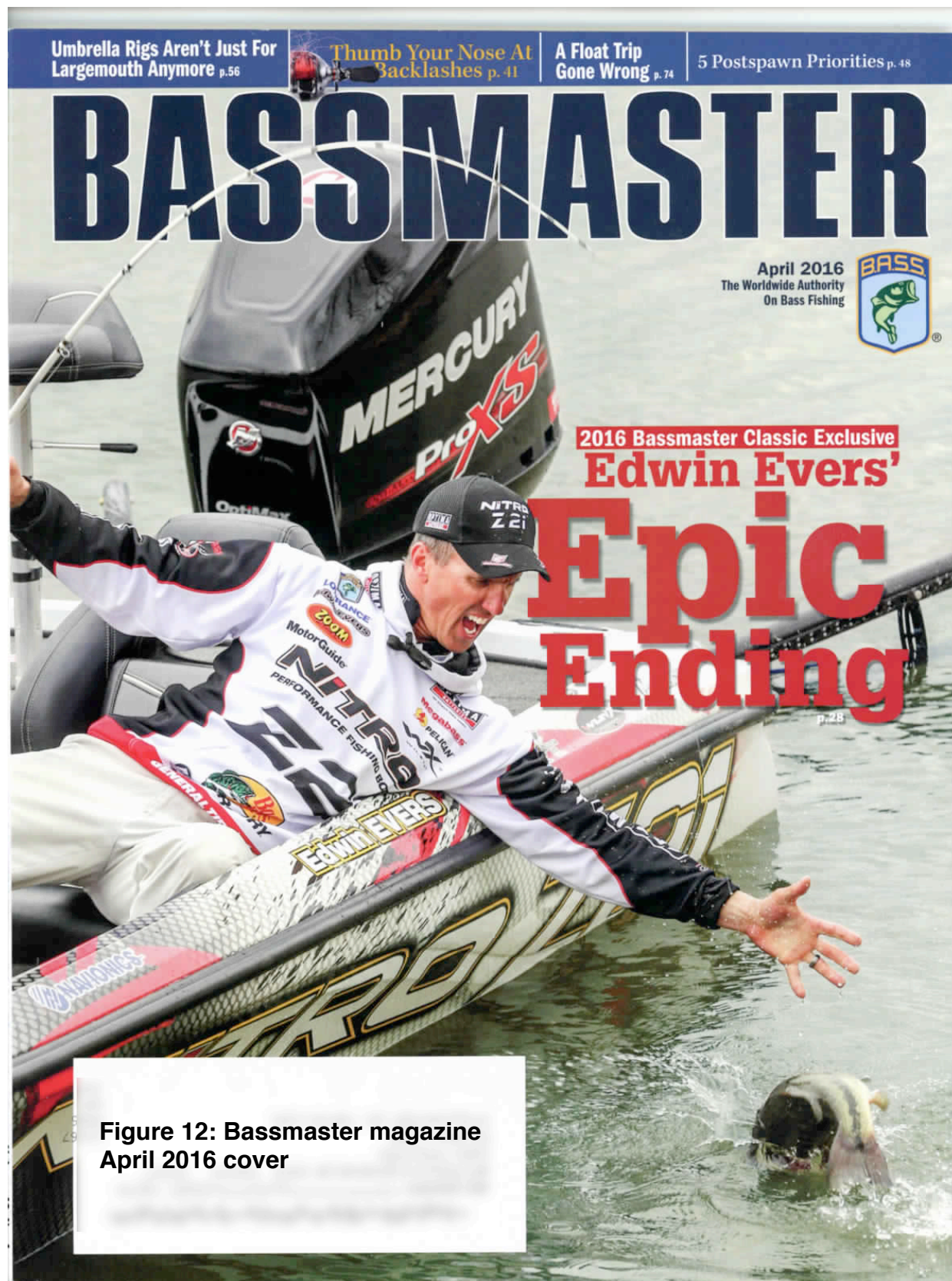


Figure 12: Bassmaster magazine
April 2016 cover

Some Bass Tournaments Impose Safety Measures

Many bass tournaments impose some of the safety measures below:

1. Require wearing of lifejackets (PFDs) when underway.
2. Require the attachment of the kill switch lanyard by the boat operator when underway.
3. Limit maximum boat horsepower to 250 horsepower which effectively limits maximum boat speeds to the 70s mph.
4. Require attendance at a safety meeting before the tournament.
5. Enforce speed limits in certain areas with spotters.
6. Blast off with a safe distance between each boat.
7. Start in some manner other than a shotgun start.

Some Bass Tournaments Try to Limit Their Legal Risks

Many bass tournaments impose some of the legal measures below:

1. Require all participants to sign a waiver.
2. Require boat operators to have some minimum amount of liability insurance on their boat.
3. Require verification of insurance by showing an insurance policy.
4. Maintain a liability insurance policy on the tournament organization and its leaders.

Boat & Outboard Motor Manufacturers

This section notes the much of the industry does not acknowledge or warn of the hazard of outboard motors breaking off and flipping into boats. Yet the same industry simultaneously introduces light weight, high horsepower outboard motors targeting tournament anglers.

Yamaha and Mercury Marine, primary manufacturers of outboard motors targeting bass tournament applications, both tout speed as a major feature of their VMAX SHO and Pro XS outboards respectively.

Neither manufacturer conducts on water log strike tests of large outboard motors at normal log strike test speeds (30 to 40 mph). Similarly, neither manufacturer conducts on water log strike tests at bass boat speeds to insure that if their outboard did break off, it would do so in a safe manner (fail-safe testing).

The combination of not warning of the “outboard motor flipped in” hazard, light weight high tech large outboard motors, ads touting how fast these light weight outboard motors can propel bass boats, while not conducting on water log strike tests for durability or for fail-safe testing is a recipe for disaster.

Boat Builders

Currently, no bass boat builders publicly acknowledge the problem. A few have been sued when anglers have been killed or injured, but we seen no warnings on any vessels or in their operator manuals.

With the problem (outboard breaking off) at the junction between the boat and the outboard motor, it looks like a great opportunity for boat builders and outboard manufacturers to work together to deploy solutions and warn of any remaining hazards.

Some bass boat manufacturers are or have been owned Brunswick and Yamaha such as Lund, Lowe, Crestliner, Skeeter, and Triton. These boats are/were an opportunity for boat builders and outboard manufacturers to work together on the hazard, but we have seen no evidence of that.

Similarly Brunswick has a longstanding relationship with Tracker and Nitro. We see no evidence of them teaming up against the hazard either.

Industry Rejects Proposed Solutions

Numerous solutions to the problem of outboard motors breaking off and flipping into boats have been proposed,¹⁹ including several patented by the industry itself. To date few of these approaches have been adopted by modern bass boats or large outboard motors.

Among the more basic proposals is use of a tether to restrain the outboard from entering the boat. In the 60s Mercury Marine patented a tether and used it on tens of thousands of outboard motors on up into the 90s.²⁰

The U.S. Coast Guard encouraged bass boat owners to tether their outboards in the early 1970s²¹ following an outboard flying into a Coast Guard vessel.

In early 2016, The Leash, entered the marketplace. See **Figure 13**.

The Leash is gaining traction among pro anglers and serious amateurs. However, bass boat and outboard motor manufacturers still ignore it, even in the face of several Mercury pro anglers advertising the product. See **Figure 13**.

Some major manufacturers of large outboard motors used in bass tournament boats have yet to publicly recognize the hazard exists.

¹⁹ Approaches to Prevent Outboard Motors From Flipping Into Boats After Striking Submerged Objects. Gary Polson. PropellerSafety.com. 25 July 2018.

²⁰ Mercury patented outboard motor tether in 1969. PropellerSafety.com by Gary Polson. Posted 19 May 2018.

²¹ The Bass Boat. Dave Cipra. USCG Boarding Officer. Panama City News - Heralds's Recreation Guide. Supplement to the News-Herald. Panama City, Florida. 2 June 1972.

**Rex Chambers Fishing**

May 3 at 8:58am · 🌐



Well, it's been FOUR years ago today, when my accident happened. There is zero doubt in my mind that if I'd been running **The LEASH** we wouldn't have had the issues of the day. Share this on your pages, and PLEASE go get one for your Boat. Could save your, your child's, your partner's life. Go to www.theleash.net and type in my name "Rex Chambers" in the promo code box when you order. That'll save you shipping costs and get ya' a free hat.



5K Views

Figure 13: Rex Chambers, Mercury Pro Angler and survivor of a flipped in accident, advertising The Leash on his FaceBook page. 3 May 2018.
See the blue strap/tether above his left hand.

Yamaha VMAX SHO & Mercury ProXS Outboards

The two big players in outboards for major bass tournaments, Yamaha and Mercury Marine / Brunswick, both have their own brand of outboards specifically targeting the tournament anglers. Yamaha's VMAX SHO and Mercury's ProXS outboards are ubiquitous at major fishing tournaments and in the bass fishing media. They can be seen in numerous photos in this paper.

Yamaha and Mercury both stress their respective bass tournament outboards are light in weight compared to their competition. Yamaha even published a paper on their efforts at weight reduction over their previous design.²² It is very obvious both design teams placed very high importance on minimizing weight of their outboards. Both manufacturers also emphasize speed. More horsepower per pound combined with gear cases designed for minimal drag leads to faster speeds.

Designing outboards for minimum weight means structural components such as the swivel bracket and mounting brackets have been trimmed of "excess weight". Lightening structural components can reduce safety margins. Mercury has already stated in legal cases that some of these collisions overwhelm their designs. As outboard motors continue to get lighter per horsepower, more log strikes will be "overwhelming" designs.

Figure 14 shows several 250 horsepower Mercury Pro XS outboards at the 2016 Bassmaster Classic before blastoff.

Yamaha VMAX SHO outboards - see **Figures 1, 2, 5**

Mercury Pro XS outboards - see **Figures 3, 6, 11, 12, 13, 14, 20**

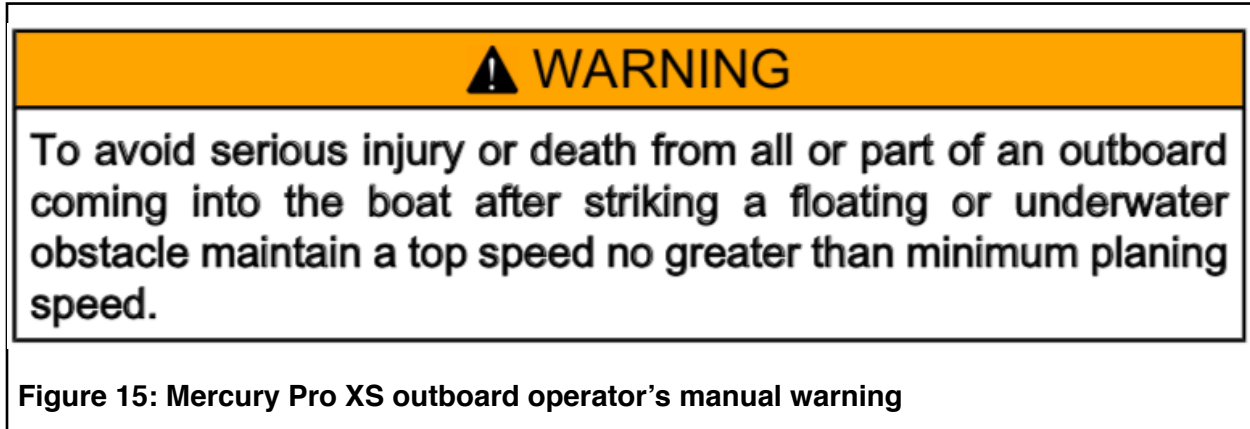
²² Development of the F200F, the lightest 4-stroke large outboard model in its class. Yamaha Motor Technical Review. 2013. Pgs. 53-57.



Figure 14: Several Mercury Pro XS outboards warming up
prior to Day 1 blastoff at 2016 Bassmaster Classic
photo by Gary Polson

Warnings

Mercury began writing about the hazard in their 1999 outboard operators manuals. More recently Mercury began adding the warning below as seen in their Pro XS outboard manual. See **Figure 15**.

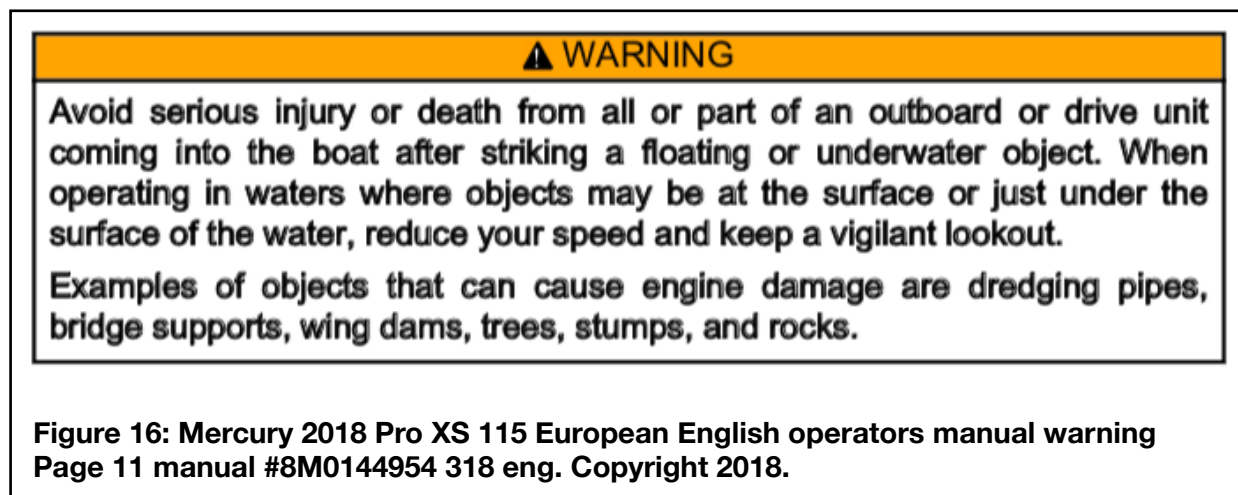


We leave it to you to evaluate the readability and understandability of Mercury's warning above. Mercury basically warns operators they risk serious injury or death if they exceed minimum planing speed with Pro XS outboards.

Bass boat passengers are struck by the outboard when it enters the boat more frequently than the operator. The operator's manual is not normally seen by a passenger, thus the passenger is at risk but not warned.

While Mercury's warning above has some problems, Yamaha and Suzuki do not warn of the hazard in their manuals or on their outboards.

Historically, Mercury has not used an actual warning for this hazard in their European manuals. We see they now have one in Europe as seen in **Figure 16** below.



No current warnings include an image of the nature of the warning on the cover of this paper which was created by Gary Polson, PropellerSafety.com

Different Outboard Manufactures See The Same Outboard Differently

Approximately 2003 through 2006 some new boats were built with Mercury 225 horsepower four-stroke outboards, but those outboards were actually manufactured by Yamaha.

While Mercury was still developing their Verado outboard they needed a 225 that would meet EPA regulations. Brunswick purchased 225 horsepower four stroke outboards from Yamaha. Mercury put a different cowl on the Yamaha 225's and rebranded them (painted black and added logos) as Mercury outboards.

These outboards were primarily used by Brunswick boat companies. During that time, Brunswick boat companies sold boats powered by 225 horsepower Yamaha outboard motors with a Mercury operator's manual²³ instructing users of the hazard of all or part of an outboard entering the boat when a floating or submerged object was struck.

During the same time frame, Yamaha was using and selling the same outboards with Yamaha cowls, paint and logos on them. Those sold by Yamaha were accompanied by a Yamaha's owners manual²⁴ which included no mention of the hazard.

These outboards were sometimes referred to in the field as a 225 Yam/Merc or as a Yamamerc.

²³ Mercury 2005 225 4-stroke outboard manual. 90-10231050 304. Copyright 2004. pdf page number 17 / manual page number 13. Yam/Merc 225 four-stroke manual.

²⁴ Yamaha 2005 F200D, LF200D, F225D, LF225D. Owner's manual. U.S.A. Edition. LIT-18626-06-07. Yam/Merc 225 four-stroke manual.

Manufacturers Log Strike Test at 30 to 40 mph

Most manufacturers of outboard motors targeting bass tournament anglers log strike test their outboard motors at about 30 to 40 mph. Kinetic energy of a moving object is proportional to velocity squared.

35 mph kinetic energy is proportional to $35 \times 35 = 1,225$

55 mph kinetic energy is proportional to $55 \times 55 = 3,025$

$3,025 / 1,225 = 2.47$

The kinetic energy of an outboard motor striking a log at 55 mph is well over twice the kinetic energy of an outboard striking a log at 35 mph.

As mentioned earlier, outboard manufacturers are generally only log strike testing up to 30 to 40 mph. Real world collisions can be much more severe than current factory log strike tests. Yamaha and the other Japanese manufacturers typically call them driftwood tests.

Manufactures say they test with the equivalent of a standard log. Bass boats can hit much larger objects including fixed objects such as stumps, concrete objects, and dredge pipes.

When boats running faster than outboards are log strike tested for run into objects larger than those tested for or fixed objects, outboard motors can break off. Some of them flip into the boat.

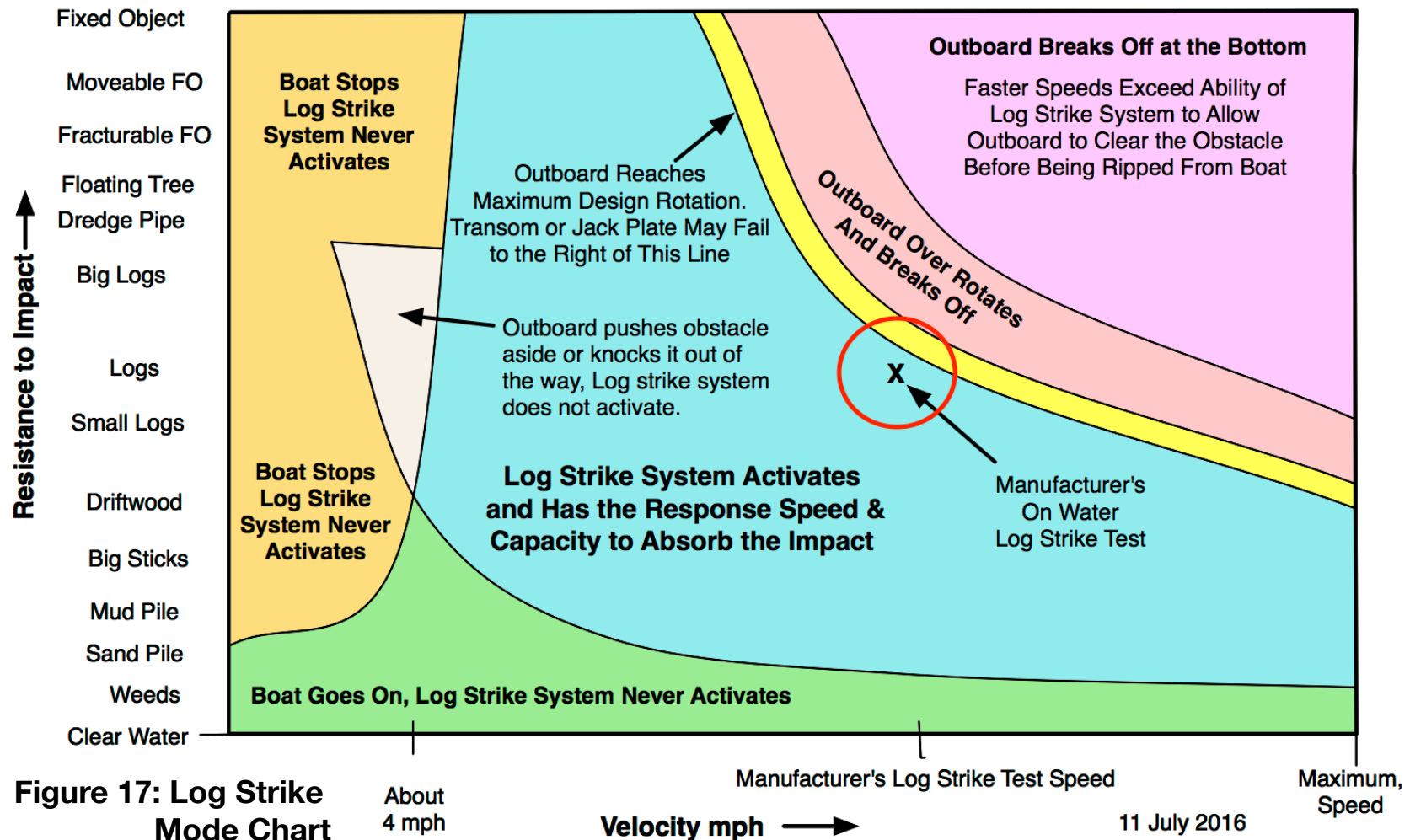
Figure 17 shows where log strike tests are currently ran (see the red circle). However, bass boats often run faster (to the right of the red circle) and strike larger or fixed objects (above the red circle). Those conditions can place the impact in the pink or lavender areas of the chart in which the outboard motor breaks off and may enter the boat.

Rough Draft For Discussion

Log Strike Mode by Speed and Resistance to Impact

Representative Log Strike Mode chart for a bass boat

Select Impact Speed on horizontal axis and object on vertical axis



**Figure 17: Log Strike
Mode Chart**

FO= fixed object such as a stump, rock, piling, or cement structure

11 July 2016

PropellerSafety.com

Log Strike Tests on Land Do Not Replicate on Water Log Strikes

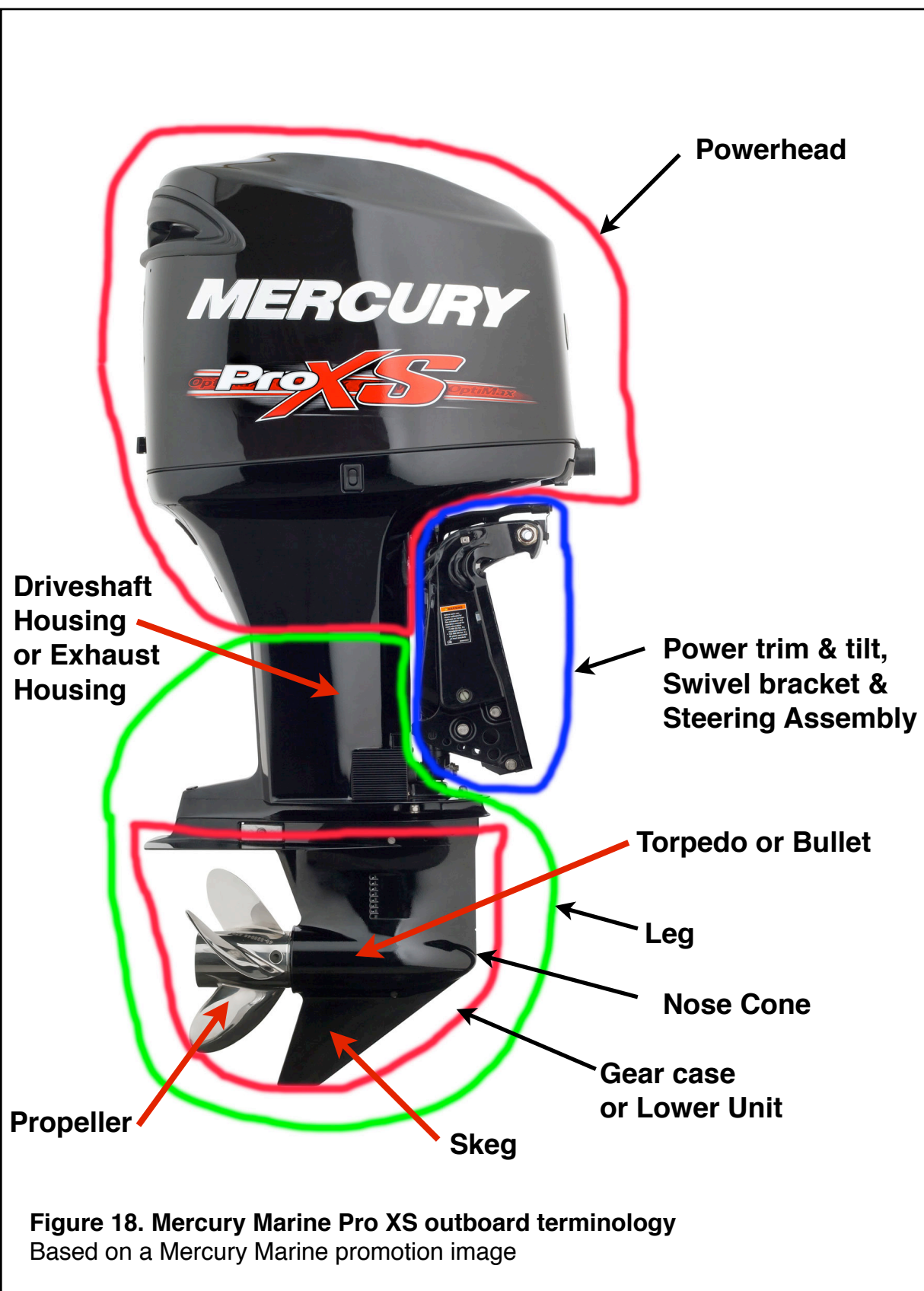
Mercury and Yamaha both conduct their log strike tests on land using test stands. A transom and outboard motor are stable while the simulated log is propelled at the outboard motor in the area of the front of the torpedo. See **Figure 18** for outboard motor component terminology.

In a real log strike on the water, the boat is moving at high speed and the log is floating reasonably stationary in the water. When the outboard breaks off, the boat quickly slows as the boat loses propulsion, falls off plane, the bow may dig into the water if the stern raised as the drive tried to clear the log. If the outboard breaks off before it clears the object (log) the outboard begins to rotate. As the boat quickly slows the outboard gains on the boat and typically falls with the propeller in the area of the passenger seat of a bass boat. In multiple instances outboards have broken off and flipped into bass boats, clearing the rear pedestal seat. See **Figure 19**.

The propeller tends to fall on the passenger because all the cables and lines attached to the starboard side of the outboard restrain the forward movement of the power head resulting in the propeller rolling over toward the passenger seat. See **Figure 19**.

For a more detailed discussion of how large outboard motors break off and flip into boats see **Appendix I**.

Dry land log strike test stands do not replicate on water conditions that allow the outboard to enter the boat. For example the outboard motor has no forward momentum during an on land log strike test. Similarly, on land log strike tests do not replicate all the lines and cables attached to the outboard motor that control the outboard's path once it breaks off. See **Figure 19**.



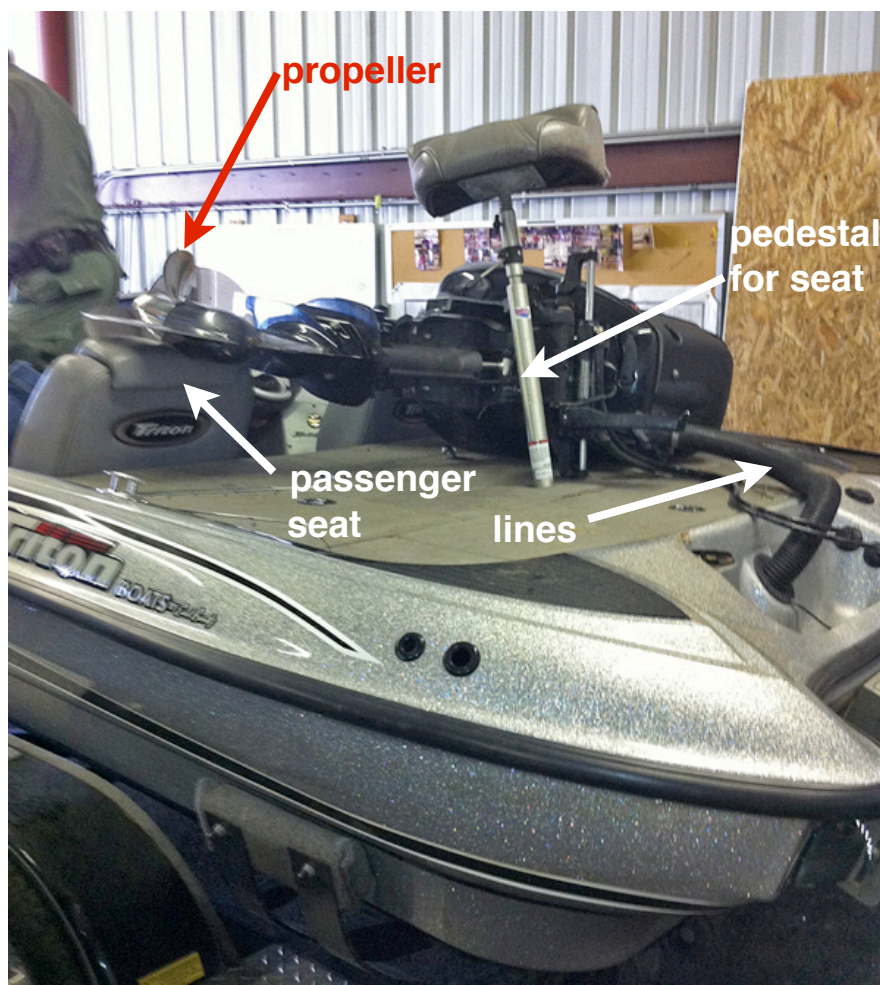


Figure 19: Outboard Flipped in Over the Rear Pedestal Seat

The photo in **Figure 19** is not staged. This is an actual accident photo. Outboards can break off, clear the rear pedestal seat, and come in with the propeller buzzing about 3,000 RPM at the passenger's head. Note the cables and lines to the outboard powerhead are still attached and a few feet of slack has been pulled out of the stern.

Fail-Safe Testing

The marine drive industry has yet to publicly recognize the difference between fail-safe testing (making sure that when marine drives do fail, they fail in a safe manner) and durability testing (log strike testing outboard motors for durability).

As mentioned earlier, the energy during collision between an outboard motor and a floating objects is proportional to the square of boat velocity. Most outboard motor manufacturers log strike test outboards at about 30 to 40 miles per hour. Many tournament bass boats run in the 50s to the 70s mph. Bass boat outboards can impact a log or fixed object with impact forces as high as 5 times the levels seen in today's log strike tests.

Figure 17 shows what happens when outboard powered boats strike a range of objects at a range of speeds. When the outboard motor strikes a large enough floating object or a fixed object at sufficient speed the outboard motor will break off. Once it breaks off, the outboard may rotate into the boat or it may break off before it clears the object, fly up and land in the boat. In both instances the engine may still be running and the propeller may be rotating at a few thousand RPM (revolutions per minute). The propeller tends to land in the area of the passenger seat headrest on a bass boat.

As shown in **Figure 17**, outboard manufacturers are conducting on water or on land log strike tests at speeds less than bass boat top speeds and with objects providing less resistance than fixed objects. The red circle represents the region log strike tests are currently conducted. In essence, they are outboard motor durability tests. Outboard motor manufacturers want the boat the outboard motor is mounted on to at least be able to limp back to shore after striking a log.

It is obvious from the chart that higher impact speeds of the same object (to the right of the circle) may land the object in the boat, OR same speed impacts of objects providing greater resistance may land the outboard in the boat (above the red circle). Even slower speed impacts of objects providing greater resistance can land the outboard in the boat (above and to the left of the red circle).

As mentioned earlier, in addition to the speed issue, manufacturers of large outboard motors are currently log strike testing on land vs. on the water. On land log strike tests do not simulate the ability outboard motors have to enter the boat in on water testing.

Compounding matters, manufacturers of large outboard motors do not fail-safe log strike test their outboards at higher speeds against larger floating or fixed objects.

Some Outboard Manufacturers Do Not Acknowledge the Hazard

To date, Mercury Marine, Bombardier / Evinrude / Johnson are the only outboard manufacturers including a statement or warning in their outboard operators manuals of the hazard.

No outboard manufacturers currently warn of the hazard in their outboard motors, on vessels powered by their outboard motors, or in boat operators manuals of boats powered by their outboards.

No outboard manufacturers currently make any effort to warn the person in the passenger seat of bass boats of the hazard, even though the passenger is the person most often struck by the outboard or propeller.

Outboard Manufacturers Market Speed

Bass tournament rules give a definite advantage to whoever can get to choice fishing holes first and spend the most time with their line in the water in areas larger bass are biting. This can lead to long high speed runs to choice fishing areas or several fast runs to multiple less distant fishing areas.

Boats with strong acceleration can also pop up and get out of shallow water easier and faster.

As shown in the earlier section, **The Quest for Speed**, manufacturers frequently show their boats and outboards running at speed. Tag lines in the ads frequently reference speed. For example, see **Figures 1,2,3,5,6**.

Figure 1, a 2014 Yamaha website VMAX SHO outboard marketing image, carries the tag line, "Get on Board or Get Out of the Way" in ALL CAPS.

Figure 20 shows Mercury's new Pro XS outboards and hints of the intense focus on speed during their design.

See the Big water = big air photos of anglers in 2016 Bassmaster Classic on Bassmaster.

These Risks Are Migrating Down Toward Entry Level Bass Boats

While this paper focuses on the increased risk of large outboard motors breaking off and entering boats during tournament fishing the problem is migrating down toward mid level and entry level bass boats. The bass tournament industry has significantly influenced the design of bass boats, the design of outboard motors, and bass fishing itself (see the earlier section on **The Commodification of Bass Tournaments**). Many of these design influences are now extending down toward mid level and entry level bass boats. Anglers not electing to move up to fully decked out tournament boats and entry level bass anglers want the features of tournament boats on their boat, including faster speeds.

Recall the earlier section in this paper on **The Science of Leisure**, and more specifically the discussion of Serious Leisure:

Serious leisure: *the systematic pursuit of an amateur, hobbyist, or volunteer core activity that is highly substantial, interesting, and fulfilling and where, in the typical case, participants find a career in acquiring and expressing a combination of its (1) special skills, (2) knowledge, and (3) experience.*²⁵

Bass fishing is less interesting and less fulfilling for mid level and entry level bass anglers unless their boat has at least some of the features of high end tournament bass boats. As per the serious leisure definition above, mid level and entry level anglers are unable to develop special skills with features and devices not present on their vessel. Similarly their experiences are less fulfilling without these features and devices.

Smaller, lower cost, mid level and entry level bass boats now fill this void by incorporating several features present on larger, much more expensive, high end tournament boats. These mid level and entry level bass boats are smaller (not as long), provide a mix of features from high end tournament boats while still trying to hold the price down. One way they hold the price down is to use smaller, lower horsepower outboard motors.

High end tournament bass boats are very expensive. They are normally powered by 200 to 250 horsepower outboard motors with special tournament model branding on them such as Mercury's Pro XS or Yamaha's VMAX SHO outboards.

In recent years outboard motor manufacturers recognized the opportunity to extend the tournament outboard lines to lower horsepower outboards. Now mid level and entry level bass anglers can begin developing some of the skills of pro anglers and feel like they are having similar experiences.

²⁵ Definition from The Serious Leisure Perspective (SLP) on SeriousLeisure.Net

For example, Yamaha announced the extension of their VMAX SHO bass tournament outboard motor line down to 115 horsepower in 2014.²⁶ In response, on February 2018, Mercury Marine introduced their 115 Pro XS outboard motor.²⁷ On that same day, Yamaha countered by introducing their new 90 horsepower VMAX SHO outboard motor.²⁸ It takes little imagination to envision Mercury countering with their own 90 horsepower Pro XS outboard.

The introduction of light weight, lower horsepower tournament branded outboard motors may allow those in mid level and entry level bass boats to have more fulfilling experiences. However, these smaller light weight outboards also bring increased speeds and increased risks of outboard motors breaking off and entering boats to a group of anglers largely unaware the hazard even exists.

²⁶ Yamaha VMAX SHO 115 introduced on 9 October 2014. Yamaha Unveils New Outboards for Freshwater Market. Chris Landry. Soundings Trade Only Today. 10 October 2014.

²⁷ Mercury Pro XS 115 introduced 15 February 2018. Mercury Marine Announces New 115 Pro XS Outboard. Mercury Marine News. 15 February 2018.

²⁸ Yamaha VMAX SHO 90 introduced 15 February 2018. Yamaha Marine Introduces New Power, New Control and New Outboard Features for 2018. Business Wire. 15 February 2018.

The Fish Themselves

Bass are practically engineered as a tournament fish for the common man. Found across the United States, they are illusive, but not too hard to find. Largemouth and smallmouth bass put up a great fight but can be landed fairly quickly. Bass spend much of their lives in areas challenging to reach with boats or challenging to fish in such as shallow water, near stumps, rocks, downed trees, brush, and vegetation. They spawn in shallow water. Bass are picky about what kind of lure, color of lure, size of lure, and presentation they will bite, while being hardy enough to be caught and released after the tournament. Tournament fishermen use countless lures, and techniques to get to and catch bass at various times of the year, in an unending variety of water temperatures, water depths, underwater structures, vegetation, water clarity, and manmade structures. Many rural Americans were drawn to bass fishing for their taste and size.



Figure 21: Caleb Summrell of Louisiana at the 2018 Bass Pro Shops Bassmaster Open Championship on Table Rock Lake. Bassmaster image.

In Closing

In hindsight it is no surprise outboard motors on bass boats used in bass tournaments strike submerged objects, break off and flip into boats considering:

1. The necessary Components, Operating Characteristics, Object, Operator, Boat Design, and Water Characteristics for outboard motors to strike submerged objects, break off, and flip into boats all come together in the bass tournament fishing environment.
2. Tournament anglers sense of haste combined with the industry's quest for speed.
3. The development of bass buggies - high end fishing machines, capable of running fast, loaded with all the technology possible to hunt down bass and land them. These vessels increase the distances covered by many anglers.
4. Bass spend much of their lives in shallow water near floating and underwater obstructions.
5. Millions of obstacles are in the water at any one time in areas bass habitate or bass anglers pass through at speed to get to bass.
6. The industry's promotional materials showing bass boats running at speed in shallow water with poor visibility.
7. Most submerged objects that can be struck by outboard motors are invisible at speed.
8. Boater fatigue causes boaters to take longer to identify floating hazards and be slower to react to the ones they do identify.
9. The boating industry has yet to apply many available alternative designs to modern boats and outboard motors to prevent the hazard.
10. The boating industry does not log strike test outboards in conditions similar to those experienced in bass tournaments.
11. The boating industry does not test outboards to make sure they fail in a safe manner if they do break off.
12. Boat builders do not publicly recognize the hazard.
13. Two manufacturers of outboard motors for tournament bass boats have yet to publicly acknowledge these accidents exist (Suzuki and Yamaha).
14. Outboard manufacturers that do publicly recognize the hazard do not effectively warn of the hazard.

15. The business of bass tournaments has been extremely successful. As a result, tens of thousands of participants have been drawn to tournament fishing, and to the hazard of striking floating or submerged objects at speed.
16. The structure of bass tournaments has evolved in a manner that draws even more people to the activity (use your own boat, use of marshals, heaviest 5 fish, catch and release, a series of tournaments to determine a winner, colorful boats and contestants, media coverage including a strong Internet presence, substantial prizes, ability to be an armchair pro angler).
17. Recent turmoil among major bass tournament organizations may currently be bringing more anglers to the pro rankings resulting in more people on the water most of the year running at speed.
18. As tournament branded bass motors become available in lower horsepower models, a new segment of the population is being exposed to the hazard of outboard motors breaking off and entering boats. Making matters worse, many novice and experienced bass anglers are not aware the hazard even exists.

The business of bass tournaments, bass tournament conditions, and boat & outboard motor manufacturers bring together the elements required for outboard motors to break off and flip into boats as seen in **Figure 22**.

Some anglers purchase tournament bass boats but do not compete in actual tournaments. These anglers are similarly at risk because they still have two sides of the process shown in **Figure 22** working against them.

Even anglers in smaller, more economical bass boats are at risk. See the section of this paper titled, **These Risks Are Migrating Down Toward Entry Level Bass Boats**.

Please note this paper is in no way an attack on bass fishing, bass tournaments, bass tournament organizations, bass boat builders, or outboard motor manufacturers. Bass fishing and bass tournaments are great, wholesome, family, outdoor recreational activities. Many of those who compete at the pro level are “Following the Dream”. This paper is purely an effort to point out why outboard motors on bass boats are breaking off and flipping into / entering boats at a greater frequency than large outboards on other types of vessels.

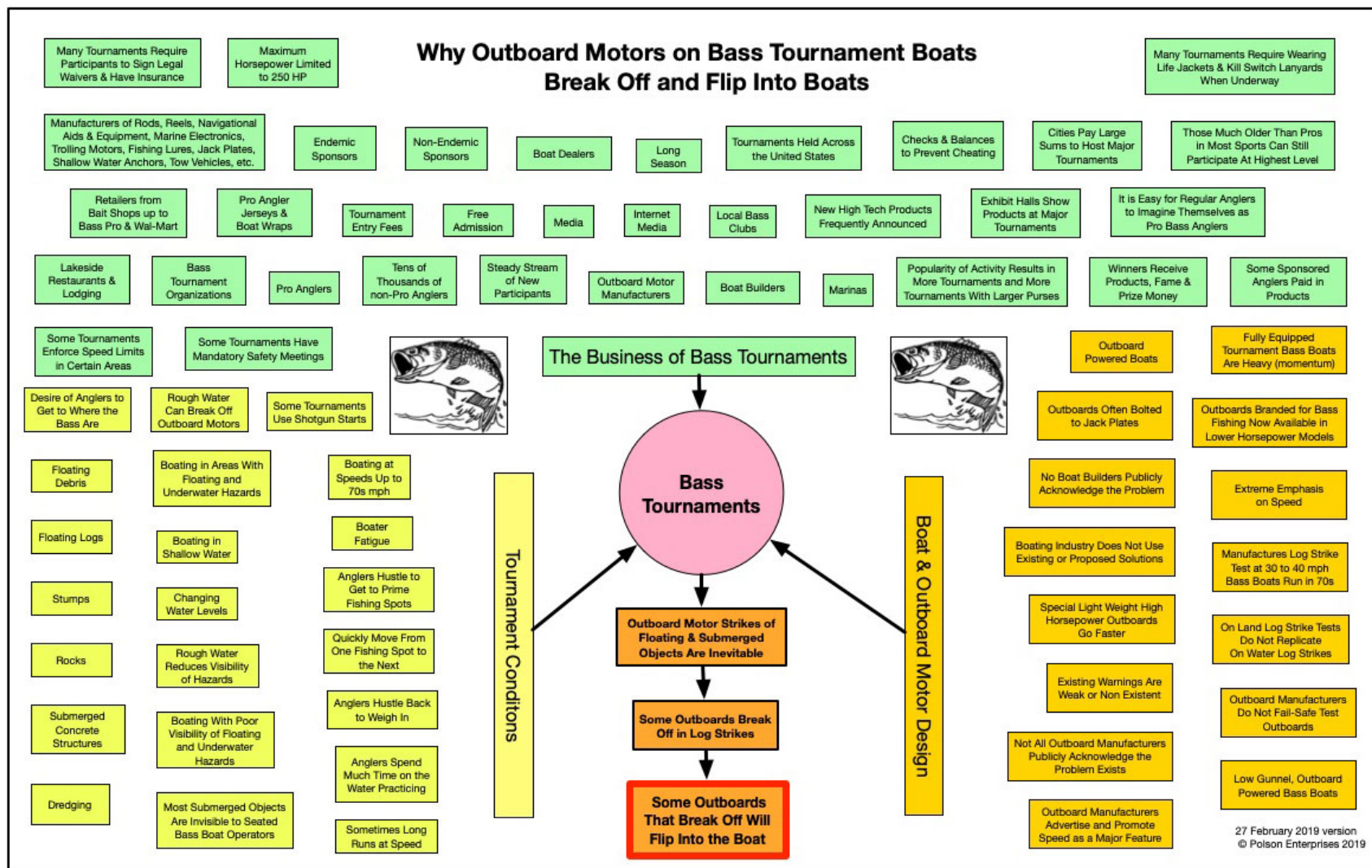


Figure 22: Why Outboard Motors Break Off and Flip Into Boats

Appendix I

How Outboard Motors Break Off and Flip Into Boats

A1.1 Definitions

Some boat and outboard motor parts and features are known by various names. These definitions will help clarify discussions that follow.

Definitions:

Stern - the back / rear of a boat

Jack plate - metal stand off box between outboard motor and transom of many bass boats. Allows the outboard to be vertically raised and lowered. Some allow the outboard to be vertically raised and lowered while underway.

Transom - The flat vertical surface that forms the stern of a boat. The outboard motor or jack plate is bolted to the transom.

Outboard motor - self contained propulsion unit that bolts or clamps to the transom (see **Figure 23**)

Trim - to change the propeller shaft angle with respect to the boat, typically along an arc as seen in **Figure 23**.

Tilt - raising the outboard even higher along the arc into a trailering position as seen in **Figure 23**. An outboard motor may "kick up" into the tilt range when it strikes a floating or submerged object.

A1.2 Most Large Outboard Motors Are Bolted On

Most recreational power boats are powered by outboard motors. Early outboard motors were often portable and clamped to the boat's transom. Smaller outboard motors are often still clamped on today. Larger outboard motors typically bolt to the transom or to a jack plate.

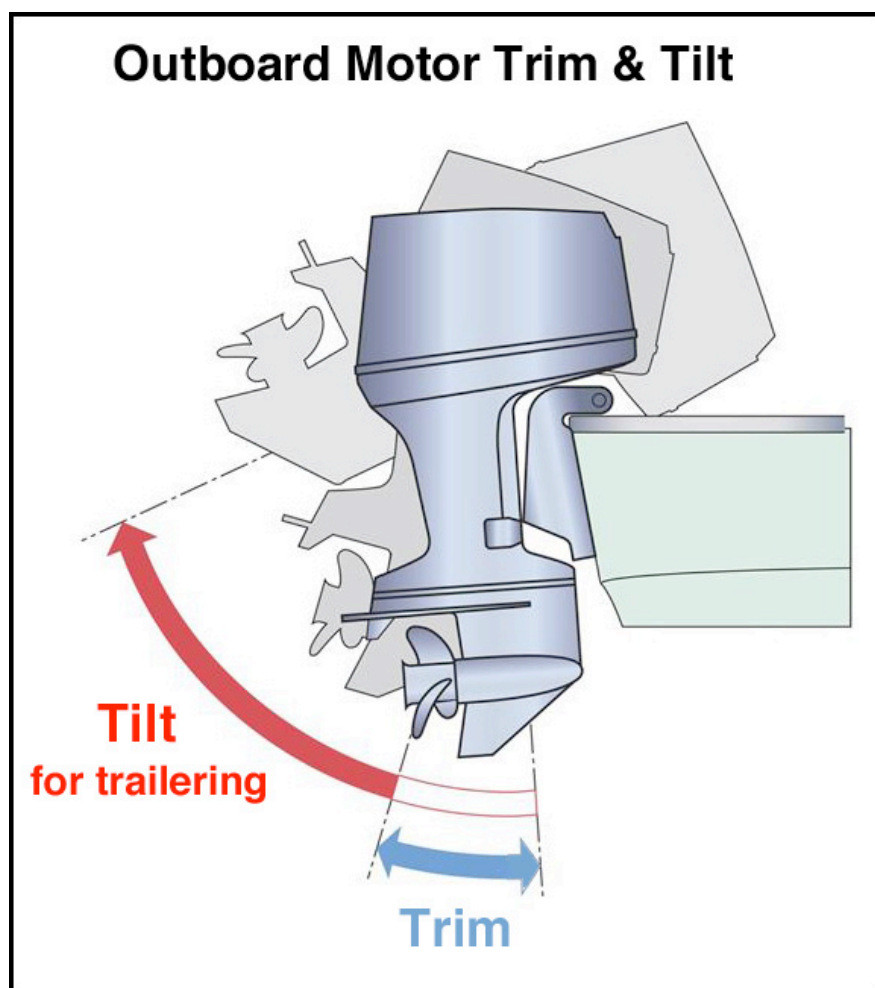


Figure 23: Outboard Motor Trim and Tilt
developed from a Yamaha image

A1.3 Strain Energy

Some energy from outboard motors striking floating or submerged objects is absorbed as strain energy by many structural components as they “stretch” during impact. Those structural components include the transom, transom brackets, tilt tube, steering arm / swivel pin, swivel bracket, tilt cylinder metal barrel, tilt cylinder rod, tilt cylinder mounting pins, motor mounts, jack plate, jack plate mounting bolts, and motor mounting bolts. If these components do not break or permanently deform during impact, they absorb energy by stretching or bending, then release much of that energy as they return back to their normal shape. Similarly, energy is often expended on the object struck as it is chopped or otherwise deformed.

A1.4 Large Outboard Motors Trim & Tilt Hydraulically

Large outboard motors typically trim and tilt hydraulically. They also typically use the hydraulic trim & tilt system to cushion impacts with floating or submerged objects. The hydraulic cushioning system (often called a log strike system) is typically contained within the tilt cylinder. This system absorbs energy as the outboard motor swings up along the trim/tilt arc, seen in **Figure 23**, clears the floating or submerged object, and continues to rotate upward. When the energy has been dissipated, the hydraulic trim/tilt system allows the outboard to settle back down to its previous running trim (depth).

A1.5 Power Trim & Tilt Systems Absorb Outboard Motor Impacts

Modern large outboard motors typically use their hydraulic power tilt & trim systems described above to absorb a significant portion of the energy when floating or submerged objects are struck by the outboard. A common method is to build relief valves into the tilt cylinder piston.

Tilt cylinders are damped by relief valves that allow their cylinder rod to extend (allows outboard motor to swing up) when floating or submerged objects are struck. Then check valves allow the fluid to return back to the rod end side of the piston, the tilt cylinder rod retracts, and the outboard motor comes back down.

A portion of the impact energy is dissipated as the hydraulic fluid passes through relief valves as the tilt cylinder rod extends. Much of the energy dissipated by the relief valves goes into raising the temperature of the hydraulic fluid.

Mercury Marine’s modern large outboard motors build the relief valves and check valves directly into the tilt cylinder shock piston (see **Figure 24**). The relief valve function is accomplished by classic ball and spring relief valves. Several of these ball and spring relief valves are built into the piston to handle high flow rates during impact. Similarly, balls and much lighter springs are installed in the tilt cylinder shock piston for use as return flow check valves. Mercury includes a “memory piston”, a floating piston that normally cycles back and forth with the shock piston. During a log strike, the memory piston stays put to mark (remember) the position of the shock piston before impact. Other outboard manufacturers of large outboard motors tend to use similar designs. One large OEM (Original Equipment Manufacturer) of power tilt & trim units (Showa), does so as well.

Nomenclature: The memory piston is sometimes called a “stop piston”. The check valves are sometimes called “siphon valves”. The tilt cylinder is sometimes called a “ram”.

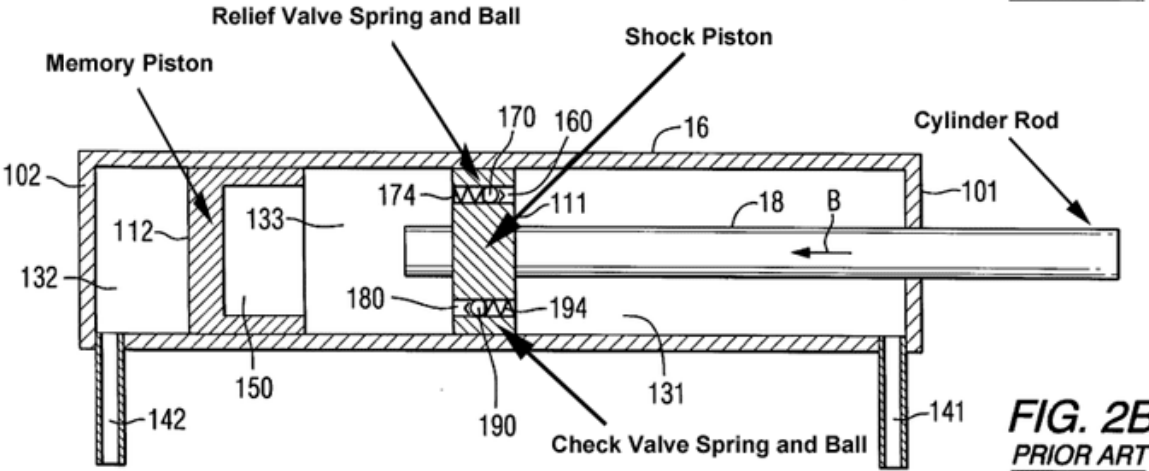
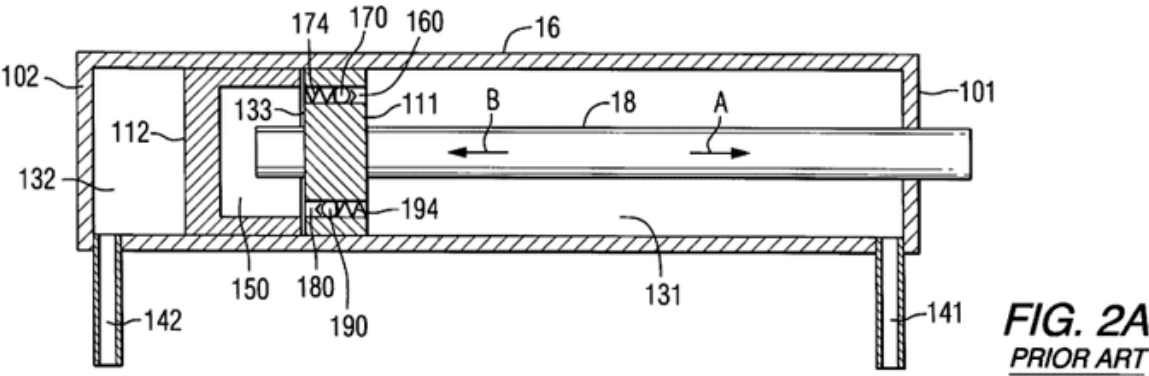


Figure 24: Basic Tilt Cylinder Log Strike System
Shown as Prior Art in Brunswick U.S. Patent 6,176,170

A1.6 Sequence of Log Strike System Event During a Design Strike

We use the phrase “Design Strike” to represent a log strike of equal or less intensity to the one the outboard was designed to survive. In a “Design Strike” the log strike system performs as designed and the outboard motor does not break off or enter the boat.

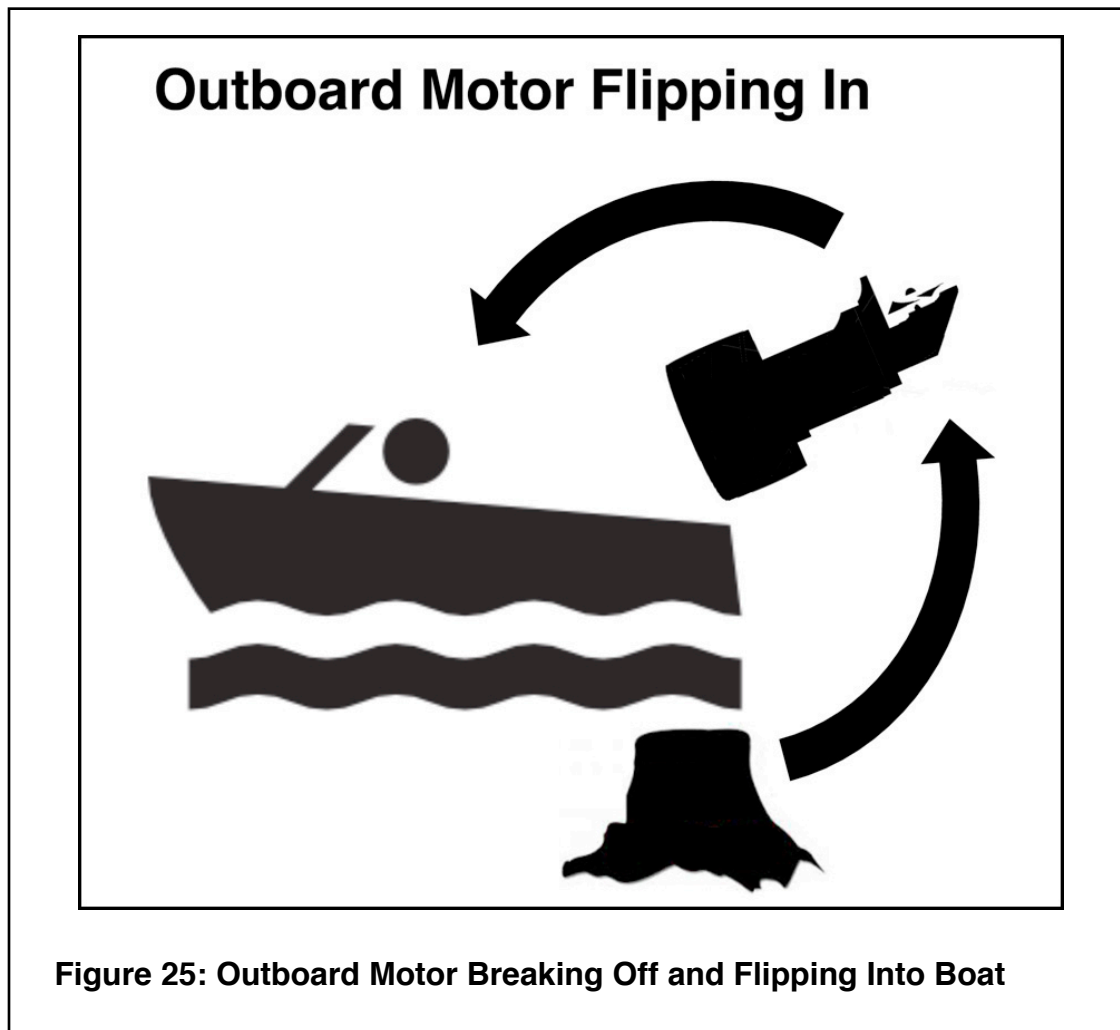
Outboard motors using log strike systems of the nature of the one shown in **Figure 24** rapidly sequence through the following steps during a “Design Strike” impact:

1. The resulting forces try to extend the cylinder rod but fluid cannot escape the rod end. The rod side pressure begins to spike (rapidly increase).
2. The transom begins to flex outward and the motor mounts begin to extend. The outboard moves slightly back from the swivel bracket as the motor mounts extend. These actions give the relief valves enough time to begin to open.
3. The rod end pressure reaches the cracking pressure of the relief valves. Relief valves begin to crack open and the rod begins to extend (fluid flows from the rod end to the cavity between the shock piston and the memory piston).
4. As pressure continues to build, the memory piston stays put, the relief valves open more fully allowing the drive to quickly swing up (more fluid passes from the rod end to the cavity between the shock piston and the memory piston as the rod extends).
5. When the propeller clears the water (breaks into the air) on the way up, the engine begins to rev up (no load on the propeller). Most modern large outboard motors have a rev limiter to prevent significantly over revving the engine.
6. As the outboard clear the object and the relief valves open more fully, the transom and motor mounts begin to return to their normal state.
7. Although the outboard quickly swings up, relief valves absorb much of the energy of the strike and slow the rate of upward rotation, The relief valves prevent the outboard from reaching maximum rotation with so much energy remaining it breaks off.
8. The outboard reaches the end of its upward swing and the weight of the drive begins pushing on the cylinder rod (that had been in tension during the upward swing) and pressure begins to build in the cavity between the memory piston and the shock piston. Fluid is forced from that cavity through check valves in the shock piston back to the rod end of the cylinder where it came from just moments earlier).
9. When the propeller re-enters the water, the engine RPM begins to slow down due to the increased load on the propeller.
10. The drive begins to settle back down and comes to rest when the shock piston comes back in contact with the memory piston

Theoretically the outboard motor is right back where it was before the log strike and none the worse for wear.

A1.7 Sometimes Outboard Motors Break Off

Sometimes the log strike system is unable to handle the impact forces. Striking fixed objects, like submerged tree stumps, at higher speeds releases tremendous amounts of energy. In these situations, sometimes all or part of the outboard motor may break off the back of the boat. In some of the instances, the outboard motor will enter or flip into the boat after it breaks off as illustrated in **Figure 25**.



When large outboard motors do enter a boat, they typically do so running. The propeller is rotating a few thousand RPM under power. Observers often report hearing the sound of a propeller out of the water.

A1.8 Different Scenarios Can Cause Outboard Motors to Enter Boats

Most outboard motors that enter a boat do so as a result of one of the seven scenarios listed in **Figure 26**.

Outboard Motor Strikes Floating or Submerged Object

& Enters Boat Failure Scenarios

Not Professional Advice
For Discussion Purposes Only

Scenario Number	Failure Scenario	Outboard Motor Can Break Off & Enter Boat
1	Outboard motor over rotates (swings up and reaches maximum tilt with too much energy, breaks off, and rolls on over into the boat). We call this Breaking Off at the Top . The front of the cowl is often crushed by slamming into the rear deck. The swivel bracket is often broken.	Yes
2	Outboard motor unable to swing up over the object fast enough (cannot clear object before forward momentum of boat rips the outboard off). We call this Breaking Off at the Bottom . Typically involves striking large floating objects, fixed objects (like stumps), or dredge pipes. Often involves failure of swivel bracket.	Yes
3	Bolts loose or broken between outboard and jack plate	Yes
4	Bolts loose or broken between jack plate and transom (or between outboard and transom)	Yes
5	Jack plate fails to retain the slide (hydraulic cylinder rod breaks off or manual plate leaves the slide) Some jack plates have cable restraints.	Yes
6	Jack plate assembly physically ripped apart and fails	Yes
7	Transom failure (portions of transom the outboard or jack plate is bolted to break off)	Yes

Figure 26: Failure Scenario Chart

Outboard Motor Breaks Off at the Bottom

Over time, several media reports and state boat accident reports of large horsepower outboard motor flipping into the boat accidents were reviewed and archived at PropellerSafety.com. As time passed, a scenario generally consistent with the accident reports, photographs, and observations of several of the more severe accidents has been developed. We call it “**Breaking Off at the Bottom**” which is **Scenario #2** in **Figure 26**.

When a large outboard motor strikes a large floating or fixed submerged object at speed, it breaks off near the bottom of its upward swing. The log strike system does not allow the outboard to clear the object fast enough. The kinetic energy of the boat creates forces too great for the mounting components, and one or more of them fail (transom brackets, swivel bracket, PTT tilt cylinder, jack plate, transom).

As the outboard swings upward and the propeller breaks the surface of the water, propulsion force diminishes to near zero, as the prop leaves the water the boat loses its bow up trim and may be knocked into a bow down trim from riding over the object, the boat instantly begins to slow down from the collision and from drag of the water. Engine RPM instantly increases as the propeller hits the air (less resistance to propeller rotation in air than in water). Eyewitnesses talk about hearing the “propeller out of water”.

As the outboard motor continues to rotate over itself and the boat begins to slow down with respect to the outboard motor, cables and lines along the starboard side of the boat to the starboard side of the outboard motor begin to pull tight. Then slack in the lines and cables begins to be pulled from where the lines exit the stern. See **Figure 27**.

These lines and cables restrict the forward movement of the starboard side of the power head relative to the boat. The leg (where the propeller is attached) continues to rotate over the powerhead and begins to lay over toward the passenger area of bass boats due to resistance from all the lines and cables pulling the starboard side of the powerhead. See **Figure 19**. The remaining energy of the collision continues to swing the propeller forward toward the passenger seat of bass boats.

The outboard motor can come in high. Multiple outboards have cleared a rear pole seat, at least one landed on top of a t-top, and one almost fell into another boat.

Often the outboards thrash around on board as the propeller strikes some combination of people, seats, the gunnel, consoles, and the deck, then goes overboard still running and sinks. The cowl is sometimes found floating nearby. The engine stops when it runs out of air or someone yanks the kill switch.

Accident scene photos often show lines and cables running over the transom (back of the boat) to a submerged outboard motor dangling from them. See **Figure 27**.



Figure 27: Outboard motor dangling from lines

Those in the passenger seat of bass boats or operators of center console boats are more likely to be struck by the propeller than bass boat operators. The propeller generally comes down in the passenger area or middle of boat, not on the right / Port side.

These collisions are very violent and happen extremely fast. Individual specific accidents will not always precisely follow the description presented here.

One factor contributing to the individuality of these incidents is the angle at which the outboard motor strikes the object. For example not all logs are struck perpendicular to the log.

We direct boat and outboard motor manufacturers wishing to address this problem to our online report:

Approaches to Prevent Outboard Motors From Flipping Into Boats After Striking Floating or Submerged Objects

Gary Polson. PropellerSafety.com.

The End