IEc

**MEMORANDUM | January 31, 2024**

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| **TO** | U.S. Coast Guard |
| **FROM** | Industrial Economics, Inc. (Webster Batista-Lin, Megan Sheahan, Jennifer Baxter) and ITA International (Dr. Peter Madsen, Dr. Robin Dillon-Merrill) |
| **SUBJECT** | Analysis of the Effectiveness of ABYC's Voluntary Standards at Improving Recreational Boating Safety (Task 5, Contract 70Z02320AMSR01100) |

This memorandum describes an analysis estimating the reduction in recreational boating accidents resulting from the adoption of the American Boat and Yacht Council (ABYC)'s voluntary standards by manufacturers of recreational boats sold to U.S. customers. In addition to presenting the evidence of the effectiveness of the voluntary standards, this memorandum offers a suggested approach for using these results to quantify the benefits of potential future USCG rulemakings incorporating all or part of these voluntary standards into the Code of Federal Regulations (CFR).

In summary, our analysis provides strong support that compliance with ABYC's voluntary standards reduces the frequency and severity of the type of boating accidents the standards are designed to address. We find that boats certified to meet ABYC's standards are 43 to 47 percent less likely to be involved in certain accidents. For accidents that occur, ABYC's standards reduce the likelihood of a fatality during the same boating accident types by 26 to 58 percent. Therefore, ABYC's standards contribute to fewer fatalities from *both* reduced boating accident occurrence and severity. We do not find robust evidence of a decreased risk of non-fatal injuries during accidents or reduced frequency of recalls; however, data limitations may be a contributor to this finding.

## 1. Background

The Federal Boat Safety Act (FBSA) of 1971 established the National Recreational Boating Safety Program and gave the USCG authority to develop and implement mandatory boat manufacturing and safety standards in an effort to improve the overall safety of recreational boating in the United States. Recreational boating fatality rates have declined significantly since the 1970s when FBSA was enacted; for instance, USCG reported 28.7 deaths per 10,000 boats in 1971 relative to 5.5 deaths per 10,000 boats in 2022 (USCG 2023a). The USCG and its boating safety partners continue to identify safety-related strategies that could further reduce boating accidents and associated fatalities.[1]

[1] The term "accident" is no longer preferred in public health injury prevention discourse. However, within boating, the term is still in use, though several actions have been taken to work towards adoption of the term "occurrence" in place of accident. Adoption (and subsequent use) of the terms "occurrence" or "incident" has not yet been formalized at USCG. Therefore, this memorandum uses the term "accident" in order to maintain consistency with existing USCG products.

As part of this strategy, the USCG is considering updates to the existing requirements for recreational boats in the CFR (USCG 2023b). Currently, USCG is engaged with ABYC—a non-profit organization that develops voluntary global safety standards for the design, construction, maintenance, and repair of recreational boats (ABYC 2021)—to solicit their proposal for potential updates to the CFR based on their experience developing standards and working with the boating community. The standards set by ABYC are the authoritative reference for product liability lawsuits in the boat building industry and the basis of certification programs, marine surveys, and other legal judgements (ABYC 2021). Based on its review, ABYC identified six priority changes to the CFR, as described in Table 1. Each of these proposed changes would further align the CFR with ABYC's voluntary standards.

Table 1. ABYC's Priority Changes to the CFR

| Priority Changes | |
|---|---|
| 1 | Apply electrical requirements to outboard motorboats |
| 2 | Apply fuel requirements to outboard motorboats |
| 3 | Introduce carbon monoxide detectors to boats with enclosed accommodation compartment(s) |
| 4 | Introduce capacity requirements for boats less than 26 feet |
| 5 | Introduce powering requirements |
| 6 | Include personal watercraft (PWC) in regulations |

**Source:** List shared with IEc on February 18, 2021

## 2. Purpose of the Analysis

The purpose of this analysis is to provide USCG with quantitative evidence on the effectiveness of ABYC's standards at improving recreational boating safety. If the USCG decides to pursue updates to the CFR, then its rulemaking process would be subject to the requirements set forth in Executive Orders 12866 and 13563 (Clinton 1993; Obama 2011), Circular A-4 (OMB 2003), and the Regulatory Flexibility Act (RFA) as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) and Executive Order 13272 (Bush 2002). USCG would be compelled to analyze the incremental costs and benefits of the proposed rules, where the benefits generally include reductions in fatalities, non-fatal injuries, and property damage associated with boating accidents.

To assist in the development of these potential future benefits analyses, USCG requested that IEc investigate the effectiveness of the CFR updates suggested by ABYC. Because data limitations impede the ability to estimate the effectiveness of any one priority change enumerated in Table 1, this assessment covers the effectiveness of ABYC's voluntary standards more broadly. Therefore, the results of this analysis could be used in a benefits assessment of any rulemaking that moves the existing CFR closer to ABYC's voluntary standards.

To date, the only known assessment of the benefits of these voluntary standards found that boats certified by the National Marine Manufacturers Association (NMMA)—which meet ABYC's standards—are seven times less likely to be recalled by the USCG for a safety issue.[2] While we were unable to find the original source study, ABYC confirmed that the underlying analysis focused on a sub-sample of recalls. Additionally, the existing assessment did not consider other safety-related outcomes of interest to USCG, including the likelihood of being involved in a boating accident as well as the consequences of those accidents (including fatalities, non-fatal injuries, and property damage). The analysis of ABYC's standards included in this report 1) considers a longer analysis timeframe, 2) makes use of all available data describing boating safety, and 3) relies on rigorous and reproducible statistical methods.

## 3. Data

The sub-sections that follow describe the data sources employed to conduct our analysis as well as the cleaning techniques required to arrive at the sample used in our assessment. These data include information necessary to identify boats built to ABYC's standards (Section 3.1), information on the frequency and severity of recreational boating accidents (Section 3.2), as well as details of recalls among recreational boats (Section 3.3).

### 3.1 Boats Built to ABYC's Voluntary Standards

Estimating the effectiveness of ABYC's voluntary standards requires a comparison of outcomes among boats adhering to the voluntary standards and those that do not implement the standards. Data do not exist describing exactly which boats meet the standards.

Instead, we used boat builder certification with NMMA as a proxy for whether a boat met ABYC's voluntary standards. The NMMA program, which certifies more than 85 percent of boats sold in the United States each year (NMMA 2018), ensures boats are built to the standards published by ABYC. NMMA's certification program requires annual inspection of all submitted boat models as well as proven demonstration that variances found during inspection are corrected and all completed products are built to the specifications of the certified design (NMMA 2021). While non-NMMA certified boat builders may choose to manufacture to ABYC's voluntary standards due to factors that we do not observe (e.g., membership in a semi-cooperative purchasing group, building for international markets with more stringent requirements, see IEc 2022), NMMA certification status represents the best available identifier of boats built to ABYC's standards for use in this analysis.

To identify which boat builders were certified at any given point in time, we utilize lists of manufacturer names for each model year between 2008 (the first year NMMA required compliance with ABYC's standards) and 2022, as provided by NMMA.[3,4] In order to match with other USCG-maintained data sources introduced in the sections that follow, the names of boat builders were

[2] This finding, for instance, is promoted through videos on NMMA's website: https://www.discoverboating.com/buying/what-is-a-certified-boat. Accessed May 16, 2022.

[3] In 2005, NMMA announced that compliance with ABYC's voluntary standards would be required for certification starting with boat model year 2008. The years between 2005 and 2008 served as a transition period, and data were not kept on which boat builders met the standards in each of those years. (Personal communication with NMMA on June 22, 2022.)

[4] Data provided via emails between NMMA and IEc on June 17, 2021 (for model years 2010-2020) and June 23, 2022 (for model years 2008-2009, 2021-2022).

matched with their unique Manufacturer Identification Code (MIC) using the USCG's MIC database.[5] Matching across NMMA's data and the USCG's MIC database proved challenging for a number of reasons described in the text box that follows. The text box also describes tests we performed to assess the success of our identification of MICs for NMMA's members as well as the implications of this imperfect matching. Ultimately, we produced a list of NMMA-certified MICs for each model year from 2008 to 2022.

**Assigning Manufacturer Identification Codes (MICs) to Boat Builders Certified by NMMA**

To match lists of certified manufacturers from NMMA with various data sources from USCG, we required a MIC for each NMMA certified boat builder. To accomplish this, we primarily employed a technique called "approximate string matching" to link the most similar manufacturer names between the lists provided by NMMA and those contained in the USCG's MIC database. Once a match was identified, the MIC from the USCG's MIC database was assigned. However, approximate string matching is limited to matching similar manufacturer names, and some manufacturers are represented by substantially different names across the datasets (e.g., "doing business as" (DBA) names, parent company names, or brand names are used).

Because the algorithm technique did not offer complete matching, we then manually assigned MICs to some NMMA manufacturers with the help of USCG and verified that the highest volume recreational boat builders were assigned the appropriate MICs through the algorithm. Additionally, we compared our list of certified MICs with those listed as NMMA members in USCG's MIC database, although USCG cautioned us that this data field was only complete as of 2020 or 2021 and does not account for variation in certification status across model years.[a]

Ultimately, we assigned 380 unique MICs to NMMA manufacturers, however we were unable to identify MICs for 10 NMMA certified boat builders (approximately 3 percent of NMMA-certified manufacturers). This means that our resulting set of MICs and model years *under-identifies* NMMA certified manufacturers.

To further assess the degree of under-identification of NMMA members, we linked the MICs of NMMA certified models with annual boat production data estimated from a vessel registration database.[b] Using our dataset of MICs for NMMA certified manufacturers, we estimate that, on average across years, 50.5 percent of boats produced in the United States are NMMA-certified; as a point of comparison, NMMA claims that 85 percent of boats sold in the United States each year are built by NMMA-certified manufacturers (NMMA 2018). This discrepancy partially accounts for our inability to assign MICs to all NMMA-certified manufacturers. However, a key challenge in comparing the two numbers is that the boat production data also contain personal watercraft (PWC) which are unlikely to be part of NMMA's calculation because PWCs are not included in NMMA's certification program (see Section 3.2).[c]

The main implication of under-identifying NMMA members is that it means we also under-identify recreational boating accidents and recalls associated with NMMA members described in Section 3.2 and Section 3.3. As a result, we assume that more boating incidents and recalls are associated with non-NMMA certified members than is true. The consequence on our statistical estimates is a reduction in the effectiveness of ABYC's standards, as further demonstrated via a simulation exercise described later in this memo. Therefore, the results in this memo can be considered conservative approximations of the true effect of ABYC's standards on recreational boating safety.

Notes and sources:
[a] Email communication between USCG and IEc on May 23, 2023.
[b] Production data was provided by Info-Link via email on February 27, 2023.
[c] Personal communication between USCG and IEc on September 5, 2023.

[5] USCG provided the most recent version of its MIC database to IEc via email on May 23, 2023.

## 3.2 Recreational Boating Accidents

The Boating Accident Report Database (BARD) is a database of Boating Accident Reports (BAR) maintained by USCG. Federal law requires that recreational boat owners or operators file a BAR if their boat was involved in an accident resulting in a fatality, injury requiring treatment beyond first aid, damage totaling at least $2,000, or the destruction of the boat. USCG provided BARD for the years 2005 to 2021, detailing over 91,000 unique accidents involving over 120,000 boats.[6] We organized the data at the boat-level and cleaned the data in three ways:[7]

1. ***Kept boats with Hull Identification Numbers (HINs) identified:*** BARD contains HINs, serial identification numbers, for the boats involved in accidents. Generally, the first three characters of the HINs are the MICs.[8] The final two characters are the model year. Because both the MIC and model year are essential for our identification of boats built by NMMA-certified manufacturers (see Section 3.1), we removed all boats without HINs or with incorrectly formatted HINs.[9] Of the 123,630 boats in BARD, 87,792 (71 percent) had complete, well-formatted HINs.

2. ***Removed boat types not covered by ABYC's standards:*** ABYC's standards apply to most, but not all, recreational boat types. To restrict our analysis to only those boat types covered by ABYC's standards and NMMA's certification program, we removed any boats identified as personal watercraft (PWC) (19,626 boat entries), rafts (4 entries), and standup paddleboards (SUPs) (5 entries).[10]

3. ***Restricted data to boats built between 2008 and 2021:*** Finally, we restricted the data to boats with model years that matched our NMMA-certification data, from 2008 to 2021.

Our final analysis dataset contained 12,271 boats built between 2008 and 2021 that were associated with 11,355 boating accidents. Of the boats in our final dataset, 6,443 (53 percent) are built by an NMMA-certified manufacturer identified in Section 3.1. Apart from distinguishing NMMA-certified boats from non-NMMA-certified boats in the accident records using information contained in HINs, we use several other data elements from BARD as part of our assessment. These variables include: characteristics of the boat and operators, the presence of non-fatal injuries and fatalities, the events that occurred during the accident, and the causes of the accident. We discuss how each of these data elements are used in our analysis in Section 4.

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[6] USCG transferred BARD to IEc via its SAFE system on March 22, 2023.

[7] In consultation with USCG and ABYC, we decided to conduct the analysis at the boat-level as opposed to the accident-level. This is because it is uncertain how NMMA certification of one boat may affect the outcomes of any other boats involved in the same accident. (Personal communication between USCG, ABYC, and IEc on August 24, 2023).

[8] In HINs, the first three characters generally indicate the MIC code. However, the initial characters may indicate states in the case of state-assigned HINs or country of origin. Based on feedback from the USCG, we accounted for these possibilities in our method for extracting MIC codes from HINs and adjusted accordingly.

[9] BARD also contains separate fields for boat manufacturer name and model year, although this information is often incomplete and inconsistently recorded. Given the sample size of boats with complete HINs, we did not pursue using these additional data fields.

[10] Personal communication between USCG and IEc on September 5, 2023, and email communication on September 12, 2023.

## 3.3 Recreational Boat Recalls

The USCG's Boating Safety Division is responsible for issuing recalls of recreational boats that fail to comply with existing regulations or contain defects that create a substantial risk of personal injury to the public. These issues may be detected and reported by a manufacturer or the USCG as part of routine inspections or safety-related tests. USCG maintains records of past recalls and provided these data for our assessment.[11] Various characteristics of each recall case are recorded, including the MIC of the manufacturer and model year of the boat.[12] These two pieces of information allow us to identify which recalls correspond with NMMA certified boats and non-NMMA certified boats by matching with the data described in Section 3.1. Other variables in the database help us to identify the set of recalls of interest to this assessment. For instance:

1. ***Removed non-boat recalls:*** The MIC variable distinguishes engine or equipment manufacturers from boat manufacturers.[13] Because ABYC's standards apply to boat manufacturers only, we exclude the engine and equipment manufacturer recalls.
2. ***Removed boat types not covered by ABYC's standards:*** The data also provide an entry for boat type. Although blank in many cases, we exclude any recall tagged as a PWC because ABYC's standards do not apply to these boats; rafts and SUPs are not among the boat types classified in the recall database.[14] By keeping the blank boat type entries, we may over-estimate the number of recalls associated with non-NMMA members.
3. ***Restricted data to boats built between 2008 and 2022:*** Finally, we restricted the data to boats with model years that matched our NMMA-certification data.

A significant limitation of the recall data for our purposes is that it contains entries for more routine administrative recalls that are not safety related, and there is no standard way to identify which recalls are administrative and which are safety related.[15] While some entries contain notes that offer some insight into the nature of the recall, this information is not provided for all entries and is challenging to decipher when available. Therefore, our analysis includes all types of recalls recorded by USCG.

Our final analysis dataset contains 364 recalls issued for boats with model years between 2008 and 2022. Our analysis also considers the number of units associated with a recall; another variable contained in the database.

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[11] Data provided by USCG to IEc via email on May 19, 2022.

[12] While MICs are provided for all recalls, model years are blank in 38 percent of recall cases. To identify the model years for boats with missing information, we use the case year and case open date. For cases that were initiated in January through June, we assume the model year is the case year. For cases opened in July through December, we assume the model year is one year after the case year. This data cleaning method was vetted by USCG staff during a call on October 16, 2023.

[13] These cases are denoted using codes "111" and "999."

[14] In addition to using the boat type field to exclude PWCs, we also reviewed the "notes" section to identify and exclude other recalls where PWCs are mentioned in the text description.

[15] Examples of non-safety related recalls include: failure to submit required paperwork, improperly formatted HIN, and missing capacity plates.

# 4. Methodological Approach and Findings

We estimate the effect of ABYC's voluntary standards on three safety-related outcomes: 1) frequency of involvement in recreational boating accidents, 2) severity of boating accidents (measured using fatalities and non-fatal injuries) and 3) the frequency of boat recalls.[16] Each of these assessments involves a slightly different analytic approach and interpretation. Therefore, we describe the method and results separately for each safety outcome.

## 4.1 Boating Accident Frequency

### 4.1.1 Methods

To estimate the effect of ABYC's standards on the frequency of boating accidents, we can compare the outcomes for a set of boats that meet the ABYC's standards to the outcomes of a control set that do not. However, this comparison could be biased if either set of boats is exposed to a relatively higher or lower risk of accident. For example, if boats meeting ABYC's standards are used more frequently, then they could be over-represented in the accident data, and estimates drawn directly from comparing accident frequency could be biased. Typically, in risk analysis, this problem is addressed by normalizing the accident rates using a measure of their exposure to risk (e.g., miles traveled, time on the water).

Data are not available that can directly describe the exposure of recreational boats to the risk of accident. Instead, we use a methodology called quasi-induced exposure (QIE), an analytic technique designed to study how various factors influence the likelihood of accident occurrence in contexts where exposure data are limited or unavailable.[17] QIE is an accepted methodology in the study of road accidents (e.g., Keall and Newstead 2009) but does not appear to be well known in the broader risk analysis community. For example, we can find no examples of QIE being used previously to study maritime accidents.

QIE is used here to study the effect of ABYC's standards on accident involvement among a set of accidents where ABYC's standards should reduce risk. This involves identifying types of accidents in BARD that should be unaffected by ABYC's standards and therefore equally likely among NMMA certified and non-NMMA certified boats. The rationale is that the rate of involvement of boats in the non-affected accidents approximates their exposure to risk and is not correlated with NMMA certification.

In consultation with USCG and ABYC, we classified the primary events (the first event in the accident) and causes (the most important contributing factor to the accident) of accidents included in BARD into three categories: 1) directly related to the ABYC's standards, 2) indirectly related to

[16] We considered but ultimately decided against assessing property damage from boating accidents as a separate measure of boating accident severity. This decision was made for a few key reasons: 1) significant under-reporting of property damage in USCG's BARD data (IEc 2023) and 2) the potential for correlation between NMMA certification status and the value of a boat, which could influence the amount of assessed property damage.

[17] For more details on the QIE method, please see Stamatiadis and Deacon (1997) or Jiang et al. (2014).

the ABYC's standards, and 3) unrelated to the ABYC's standards (see Table 2).[18] For instance, the voluntary standards should not influence the frequency of accidents where the primary event is skier mishap, fall in vessel, or person departed vessel. On the other hand, ABYC's standards address manufacturing specifications that seek to limit fire and explosions, grounding, flooding/swamping, capsizing, and select other events, therefore the standards are most likely to affect the likelihood of accidents in this set. Many of the accident events in the indirectly affected category include collisions because ABYC's standards improve the boat operator's visibility, one of many other conditions that may contribute to collisions. For use with the QIE approach, we consider events and causes classified as unrelated to ABYC's standards to constitute the set of non-relevant accidents, which are used to approximate exposure to accident risk.

**Table 2: Classification of BARD Accident Causes and Events by Relationship with ABYC's Standards**

| Accident Events Directly Related to ABYC's Standards | Accident Causes Directly Related to ABYC's Standards | Accident Events Indirectly Related to ABYC's Standards | Accident Events and Causes Unrelated to ABYC's Standards |
|---|---|---|---|
| Flooding/swamping | Machinery failure | Person ejected from vessel | Fall in vessel |
| Capsizing | Improper loading | Collision with recreational boating vessel | Person struck by vessel |
| Grounding | Equipment failure | Collision with fixed object | Skier mishap |
| Person stuck by propeller | Overloading | Falls overboard | Person departed vessel |
| Sinking | Hull failure | Collision with submerged object | Other |
| Fire/explosion (non-fuel) | Ignition of spilled fuel or vapor | Collision with floating object | Sudden medical condition |
| Fire/explosion (fuel) | Inadequate onboard navigation lights | Collision with vessel | Unknown |
| Fire/explosion (unknown origin) | Failure to vent | Collision with commercial vessel | *+ an additional 41 causes determined to be unrelated to ABYC's standards* |
| Carbon monoxide exposure | Carbon monoxide exposure | Collision with governmental vessel | |
| Electrocution | Off-throttle steering loss | | |

**Source:** Categorization accomplished during call between IEc, ABYC, and USCG on August 24, 2023.

**Note:** Events and causes are sorted by frequency of occurrence in the BARD data, with more frequently occurring accidents at the top of each column and less frequently occurring accidents at the bottom of each column.

[18] In BARD, each accident can be assigned up to four causes and four events. We consider the first cause (recorded as AccidentCause1) to be the primary cause, and the first event (AccidentEvent1) to be the primary event. If either the primary event or primary cause is directly related to ABYC's standards, then we code the accident as directly related to the -standards. If the primary event is indirectly related to ABYC's Standards and the primary cause is unrelated to ABYC's standards, then we code the accident as indirectly related to ABYC's standards. If neither the primary cause nor the primary event is directly or indirectly related to ABYC's standards, then we code the accident as unrelated to ABYC's standards.

Consistent with terminology used in other QIE studies, we combine the accident causes and events directly or indirectly related to the ABYC's standards into a "focused" set of accident types (dark and light gray columns in Table 2) and all accident causes and types unrelated to ABYC's standards into a "non-focused" set of accidents (white column in Table 2). We use the classification of focused and non-focused accident types as well as the identified boats built by NMMA-certified manufacturers to define four subgroups of boats in the accident data, as shown in Table 3: (A) NMMA-certified boats in focused accidents, (B) non-NMMA-certified boats in focused accidents, (C) NMMA-certified boats in non-focused accidents, and (D) non-NMMA-certified boats in non-focused accidents.

**Table 3. QIE Subgroups for Analysis of Accident Frequency**

| | NMMA-certified boats | Non-NMMA-certified boats |
|---|---|---|
| **Focused accidents** | A | B |
| **Non-focused accidents** | C | D |

The estimate of interest in the quasi-induced exposure model is referred to as the relative accident involvement ratio (RAIR), and is defined as:

$$RAIR = \frac{A/C}{B/D} \quad (1)$$

where A/C is the odds of an NMMA-certified boat in a focused accident relative to non-focused accident and B/D is the same for non-NMMA certified boats. The RAIR is an odds ratio that represents the relative propensity of NMMA-certified boats to be involved in focused accidents in comparison to non-NMMA-certified boats. If $RAIR < 1$, then NMMA-certified boats are less likely to be involved in focused accidents, and ABYC's standards are effective at reducing boating accident frequency.

An advantageous feature of QIE is that it can be reformulated as a logistic regression model, which allows for the addition of control variables. For accident likelihood, we estimate variations of Equation 2 with different control variables, including other characteristics of the boat, conditions at the time of accident, and operator experience.

$$\ln\left(\frac{probability\ of\ focused\ accident}{probability\ of\ non-focused\ accident}\right) = \alpha + \beta(nmma) + \gamma(controls) \quad (2)$$

In the logistic model, $\beta$ is our coefficient of interest and is expressed as the log-odds of the RAIR: $\ln\left(\frac{A/C}{B/D}\right)$. We exponentiate $\beta$ to recover the odds ratio from which we estimate the percent change in the odds of boats built to the ABYC's standards being involved in focused accidents relative to boats not built to the ABYC's standards, which can be interpreted as the percent reduction in focused accident frequency. We test for statistical significance using a Wald test.[19]

[19] Pennsylvania State University's Department of Statistics provides a rigorous introduction to logistic regression models and the Wald test for significance in logistic regressions on their website: https://online.stat.psu.edu/stat462/node/207/. Accessed January 25, 2024.

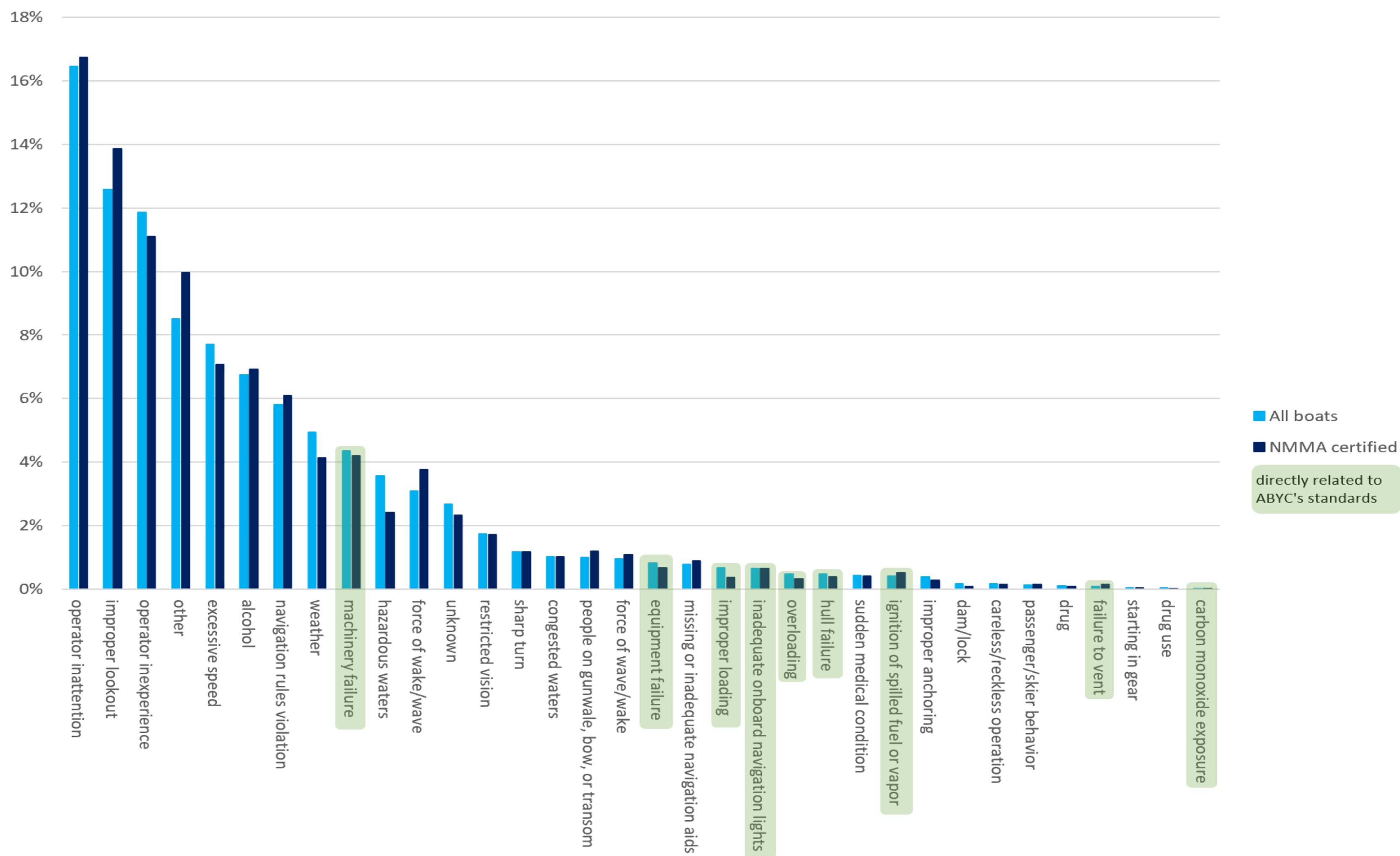
### 4.1.2 Results

Before turning to the results of our regression model, we first offer some descriptive evidence by comparing the frequency of specific types of boating accidents by NMMA certification status. In Figures 1 and 2, we chart the relative frequencies of primary causes and primary events, respectively, among accidents observed in BARD, separately for all boats with model years 2008 through 2021 and NMMA-certified boats. Figure 1 denotes the relative frequency of boats in accidents by primary cause, where causes classified as directly related to ABYC's standards are highlighted in green and all unrelated causes are not highlighted. We find that the share of all accidents among the nine causes directly related to ABYC's standards is generally smaller among NMMA-certified boats than among all boats. Overall, approximately 7.3 percent of NMMA-certified boats were involved in accident causes directly related to ABYC's standards. In contrast, this share is 7.9 percent for all boats, suggesting that the share among non-NMMA certified boats is higher than NMMA-certified boats.

Figure 2 provides the same information for accident events, which includes a classification for accident events indirectly affected by ABYC's standards. For directly affected accident events (highlighted in green), the share of accidents in these event types is smaller for NMMA-certified boats in four of nine event types. Across all nine events directly related to the standards, 17.4 percent of NMMA-certified boats were involved in these accident types relative to 20.9 percent across all boats, again suggesting NMMA-certified boats are less likely to be involved in these specific accident events. For the indirectly affected accident events (highlighted in yellow), the share of boats falling into these categories is smaller for NMMA-certified boats in seven of nine cases. Across the full set of indirectly affected accident events, NMMA-certified boats have a lower share (63.7 percent) than all boats (63.9 percent).

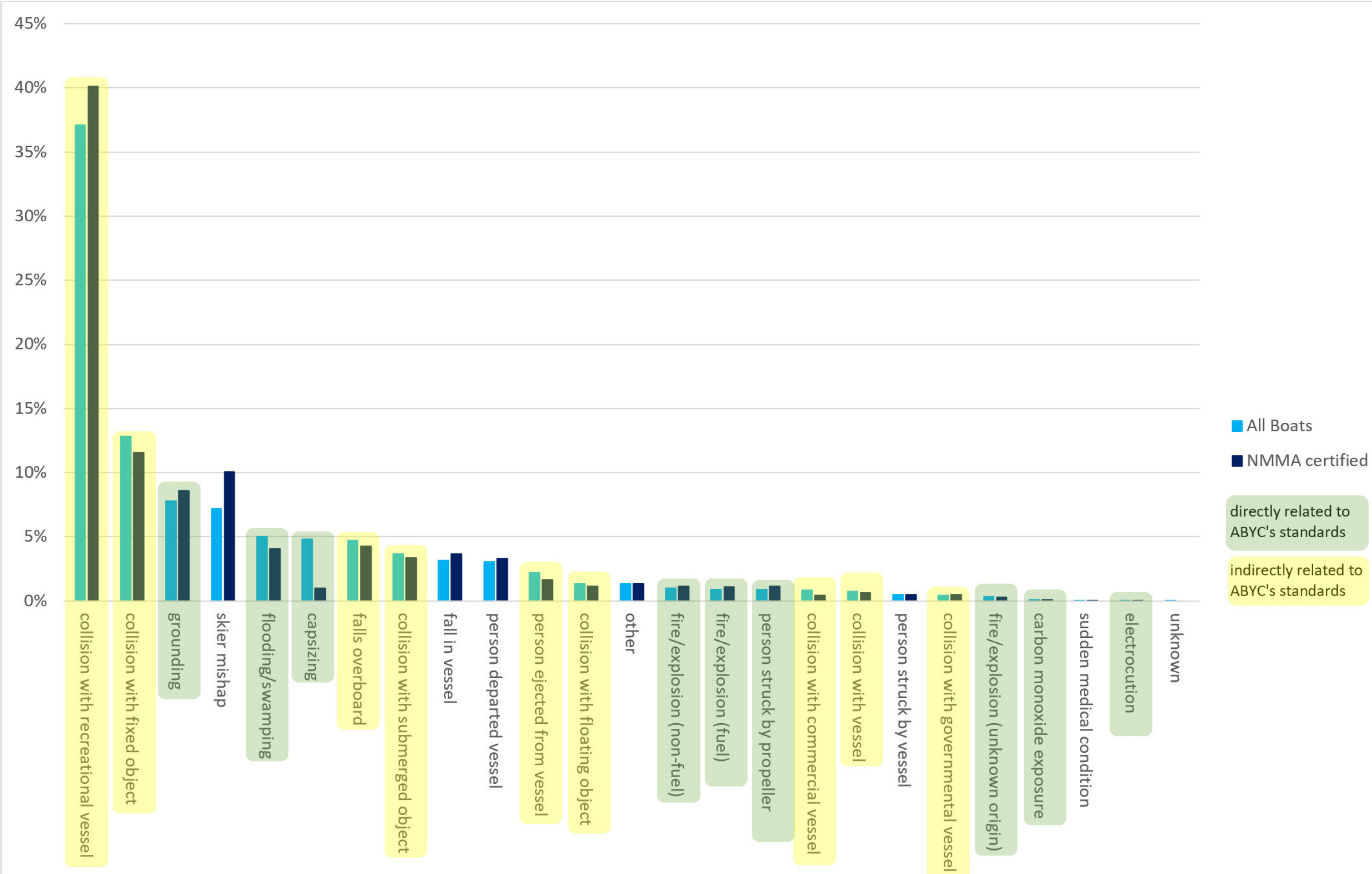
Combined, these figures show that the relative frequencies for NMMA-certified boats tend to be smaller than the frequencies of all boats among the causes and events related to ABYC's standards. This relationship is much stronger for accident types that are directly related to ABYC's standards than those that are indirectly related to ABYC's standards. This descriptive evidence provides support to the validity of our classification of BARD accidents and is suggestive of a negative relationship between ABYC's standards and the likelihood of focused events. We investigate this relationship more rigorously in the remainder of this section.

Figure 1: Relative Frequencies of Primary Causes of Boating Accidents in BARD




**Notes:** The light blue bars represent the relative frequency of the primary causes of accidents in BARD for boats with model years 2008-2021. The dark purple bars represent the relative frequency of the primary causes of accidents involving in NMMA certified boats. All primary causes that are not highlighted in green denote causes unrelated to ABYC's standards. There is no indication of indirectly related causes because USCG and ABYC only identified accident causes directly related to ABYC's standards for this set (see Table 2).

Figure 2: Relative Frequencies of Primary Events for Boating Accidents in BARD




**Notes:** The light blue bars represent the relative frequency of the primary events of accidents in BARD for boats with model years 2008-2021. The dark purple bars represent the relative frequency of the primary events of accidents involving in NMMA certified boats. All primary events that are not highlighted in green or yellow denote events unrelated to ABYC's standards.

Table 4 presents the logistic regression estimates for the effect of ABYC's standards (as proxied by NMMA-certification) on accident frequency under various model specifications. The table provides the $\beta$ coefficients and their level of statistical significance, the RAIR calculated from the coefficients, and the percent change in the odds of accident involvement (i.e., percent reduction in accident frequency). The table also indicates which variables were included as controls (if any) as well as how many observations (boats) are included in the estimation sample.

In columns 1 through 5, we restrict the boat population to only those built in 2008 through 2021. Column 7 relaxes this restriction and includes all BARD accidents that occurred in or after 2008 regardless of the model years of the boats involved; in this specification, all boats produced before 2008 are considered non-NMMA certified.[20] All models use non-focused boating accidents as the non-relevant "control" accident types, and for columns 1, 4, 5, and 6 we define focused accidents as all of those directly or indirectly related to the ABYC's standards. To investigate how ABYC's standards affect involvement in different accident types, column 2 includes only the directly related accidents whereas column 3 contains only the indirectly related accidents for comparison. We introduce two sets of control variables in columns 4 and 5: boat characteristics (column 4) and operator characteristics (column 5).[21] These controls were selected based on their likelihood of influencing accident involvement, the possibility of correlation with NMMA certification, and their completeness in BARD.[22]

All 6 model specifications provide support for the effectiveness of ABYC's standards in reducing accident frequency. The consistently negative and statistically significant coefficients indicate that NMMA-certified boats are less likely to be involved in focused accidents than non-NMMA-certified boats. The differences in magnitude across the various model specifications are intuitive and provide support for our overall findings. For instance, the relatively greater effect estimated in column 2 (only directly related focused accidents) compared to column 3 (only indirectly related focused accidents) suggests that accident types directly related to boat build are the most likely to be affected by ABYC's standards.

The introduction of control variables in columns 4 and 5 reduces the magnitude of the estimates relative to the models without control variables, suggesting that factors other than NMMA certification affect the risk of focused accidents. However, the coefficients remain negative and statistically significant with control variables (despite a reduction in sample size), providing further support of the effectiveness of the ABYC's standards over and above recorded characteristics of boats, and operators. As expected, the estimate in column 6 (where the sample includes all accidents occurring in and after 2008) is less than the other estimates, a difference we attribute to

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[20] While true that no boats were certified by NMMA prior to 2008, some boats were built to ABYC's standards before the requirement for NMMA certification in 2008. However, prior to 2008, we have no way to identify which boats adhered to the standards. This means column 6 contains potentially significant misidentification of ABYC compliant boats, a limitation that will reduce the magnitude of the true effect. We only include this model as an example of the general robustness of the estimates across specifications.

[21] We create a binary variable for operator experience, with a cut off at 100 hours. This variable was manipulated given the presence of significant outliers in the data. Otherwise, all included control variables are exactly as found in BARD.

[22] We considered other variables found in BARD as potential controls, including boat speed at time of accident. However, because not all variables are required data elements, the variables are often incomplete and, where complete, have not been validated.

error in identifying which boats met ABYC's standards before required for NMMA certification in 2008.

While the coefficient estimates are informative, the effect of ABYC's standards on focused accident risk is best described using the percent change in odds, which is equivalent to the percent reduction in the likelihood of focused accident involvement. We believe the range of estimates captured by columns 1 and 5 provides the most appropriate measures. Taken together, our results suggest that ABYC's standards reduce the risk of involvement in a focused accident by 43 to 47 percent. The appendix to this memorandum provides support for the validity of the QIE approach in this context.

Table 4. Relationship Between ABYC's Standards and Likelihood of Focused Boating Accidents (QIE Results)

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Boat Model Year | 2008-2021 | 2008-2021 | 2008-2021 | 2008-2021 | 2008-2021 | All Accidents in 2008-2021 |
| Accident Type | Direct & Indirect | Direct Only | Indirect Only | Direct & Indirect | Direct & Indirect | Direct & Indirect |
| $\hat{\beta}$ (NMMA-Certified) | -0.629<br>(-0.733, -0.526) | -0.882<br>(-1.006, -0.759) | -0.531<br>(-0.638, -0.425) | -0.475<br>(-0.578, -0.368) | -0.558<br>(-0.687, -0.431) | -0.366<br>(-0.450, -0.282) |
| Stat. Sig. | *** | *** | *** | *** | *** | *** |
| Odds Ratio (RAIR) | 0.533<br>(0.480, 0.591) | 0.414<br>(0.366, 0.468) | 0.588<br>(0.528, 0.654) | 0.622<br>(0.558, 0.693) | 0.572<br>(0.503, 0.650) | 0.693<br>(0.638, 0.754) |
| % Change in Odds | -46.693<br>(-51.966, -44.155) | -58.601<br>(-63.427, -53.169) | -41.204<br>(-47.172, -34.611) | -37.782<br>(-44.200, -30.690) | -42.768<br>(-49.672, -35.000) | -30.684<br>(-36.244, -24.577) |
| Control Variables | | | | | | |
| Boat Type | | | | x | x | x |
| Boat Length | | | | x | x | x |
| Operator Experience | | | | | x | x |
| Operator Age | | | | | x | x |
| Observations | | | | | | |
| No. Boats | 12,271 | 4,432 | 9,216 | 12,118 | 8,004 | 35,043 |
| No. Boats, NMMA | 6,443 | 2,341 | 5,089 | 6,372 | 4,190 | 4,190 |
| No. Boats, NMMA in Focused Accidents | 5,246 | 1,144 | 3,892 | 5,187 | 3,307 | 3,307 |

**Notes**: All models estimated using logistic regression per equation (2) in the main text. See Table 2 for a description of direct and indirect accident types, and the main text for more details about the control variable construction. 95% confidence intervals provided in parentheses. Statistical significance where p<0.001=***, p<0.01=**, and p<0.05*.

## 4.2 Boating Accident Severity

### 4.2.1 Methods

Given the strong evidence of a negative relationship between ABYC's standards and focused accident frequency (Section 4.1), we now seek to understand if ABYC's standards also reduce the severity of those accidents by investigating the effect of the standards on the presence of fatalities and non-fatal injuries within the focused accidents only. We use logistic regression to estimate the effect of ABYC's standards on the likelihood of a focused accident resulting in a fatality or non-fatal injury. As described in equations (3) and (4) below, the models include 1) a binary indicator of the presence of a fatality or non-fatal injury, 2) a binary indicator of NMMA certification, and 3) the same set of control variables used in Section 4.1:[23]

$$\ln\left(\frac{probability\ of\ fatality}{1 - probability\ of\ fatality}\right) = \theta + \delta_f(nmma) + \mu_f(controls) \tag{3}$$

$$\ln\left(\frac{probability\ of\ injury}{1 - probability\ of\ injury}\right) = \theta + \delta_i(nmma) + \mu_i(controls) \tag{4}$$

The coefficients $\delta_f$ and $\delta_i$ can be converted to odds ratios and percent change in odds ratio to describe whether and to what extent ABYC's standards are associated with a reduction in fatalities and non-fatal injuries during focused accidents. As in Section 4.1, the statistical significance of our estimates is measured using a Wald Test.

### 4.2.2 Results

Table 5 presents the logistic regression estimates for the effects of ABYC's standards (as proxied by NMMA-certification) on the likelihood of a focused boating accident resulting in a fatality. The consistently negative and generally statistically significant results indicate that fatalities are less likely on boats built to ABYC's standards during accident types related to the standards. As in Section 4.1 (Table 4), the effect is greater for direct accident types (column 2) than for indirect accident types (column 3), adding confidence to our categorization of accidents and model specification.

The increase in statistical significance and effect magnitude between columns 4 and 5 could indicate that estimates lacking certain control variables in columns 4 are attenuated by omitted variable bias, which is (partially) corrected in column 5. However, we note that the estimates for column 4 fall within the confidence interval of column 5, indicating that the differences between these models are not statistically significant from one another. We consider these results strongly suggestive of the effectiveness of the ABYC-standards at reducing the likelihood of accidents resulting in a fatality among focused accidents. Using columns 1 and 5 as a range, we estimate the

[23] We considered also measuring accident severity using the number of non-fatal injuries recorded for a specific accident or further standardizing non-fatal injuries using USCG's monetization approach for regulatory analysis. However, given the known underreporting of non-fatal injuries (IEc 2023) as well as the inconsistencies in which these data are categorized in BARD (e.g., changes in the type of non-fatal injury classifications used across years), we opted to use a binary variable for non-fatal injuries in the same way we do for fatalities.

ABYC's standards reduce the likelihood of a fatality during a focused boating accident by 26 to 58 percent.

In the final specification (column 6), we investigate the effect of ABYC's standards on the likelihood of a fatality during non-focused accidents, the control set of accidents unrelated to the standards. Here, the effect is negative, but the estimate is not statistically significant. We could interpret this to mean that ABYC standards do not reduce the likelihood of a fatality during these non-related accidents. However, the number of observations available for these estimates is low (1,333 boats) due to the small number of BARD accidents that have a complete set of control variables and are in the non-focused accident set. As such, the statistical power of the model in column 6 is low and may be unlikely to detect statistically significant effects even if there are true effects. Therefore, we are uncertain if ABYC's standards also reduce fatalities during accident types unrelated to the standards.

Table 6 presents the logistic regression estimates for the effect of ABYC's standards on the likelihood of a focused accident resulting in a non-fatal injury. While the majority of estimates are negative, most are not statistically significant, and we cannot rule out that the standards have no effect on the likelihood of a focused accident resulting in a non-fatal injury. There is also a positive estimate in column 6, which considers the impact of ABYC's standards on the likelihood of non-fatal injuries in non-ABYC related accidents, implying that NMMA certification is correlated with a higher likelihood of non-fatal injuries during these types of accidents. One potential explanation for the difference in findings across fatalities and non-fatal injuries is the difference in reporting to BARD; evidence consistently demonstrates that non-fatal injuries are underreported to BARD while fatalities are well-captured (IEc 2011, 2023). Further, non-fatal injuries can vary considerably in severity, and our approach of combining all non-fatal injuries into one category may mask any potential effects on particular injury types.[24] Given these data limitations, we do not consider the results of this analysis sufficient evidence of either a negative or positive relationship between ABYC's standards and non-fatal injuries.

[24] We opted to combine all non-fatal injuries into one group given the limited number of data points in certain injury type and severity categories.

Table 5. Relationship Between ABYC's Standards and Likelihood of Fatalities in Boating Accidents

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Boat Model Year | 2008-2021 | 2008-2021 | 2008-2021 | 2008-2021 | 2008-2021 | 2008-2021 |
| Accident Type | Direct & Indirect | Direct Only | Indirect Only | Direct & Indirect | Direct & Indirect | ABYC Unrelated |
| $\hat{\delta}_f$ (NMMA-Certified) | -0.859<br>(-1.00, -0.721) | -1.751<br>(-2.066, -1.455) | -0.465<br>(-0.634, -0.298) | -0.178<br>(-0.341, -0.015) | -0.307<br>(-0.509, -0.106) | -0.200<br>(-0.592, 0.202) |
| Stat. Sig. | *** | *** | *** | * | ** | |
| Odds Ratio (RAIR) | 0.424<br>(0.368, 0.486) | 0.174<br>(0.127, 0.233) | 0.628<br>(0.530, 0.742) | 0.837<br>(0.711, 0.985) | 0.736<br>(0.601, 0.899) | 0.819<br>(0.553, 1.223) |
| % Change in Odds | -57.647<br>(-63.194, -51.362) | -82.636<br>(-87.329, -76.655) | -31.198<br>(-46.958, -25.737) | -16.294<br>(-28.905, -1.453) | -26.441<br>(-39.883, -10.064) | -18.140<br>(-44.698, 22.343) |
| Control Variables | | | | | | |
| Boat Type | | | | x | x | x |
| Boat Length | | | | x | x | x |
| Operator Experience | | | | | x | x |
| Operator Age | | | | | x | x |
| Observations | | | | | | |
| No. Boats | 10,442 | 2,603 | 7,387 | 10,313 | 6,671 | 1,333 |
| No. Boats, NMMA | 5,246 | 1,144 | 3,892 | 5,187 | 3,307 | 883 |
| No. Boats, NMMA with >0 Fatalities | 316 | 52 | 255 | 316 | 197 | 84 |

**Notes:** All models estimated using logistic regression per equation (3) in the main text. See Table 2 for a description of direct and indirect accident types, and the main text for more details about the control variable construction. 95% confidence intervals provided in parentheses. Statistical significance where p<0.001=***, p<0.01=**, and p<0.05*.

Table 6. Relationship Between ABYC's Standards and Likelihood of Non-Fatal Injuries in Boating Accidents

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Boat Model Year | 2008-2021 | 2008-2021 | 2008-2021 | 2008-2021 | 2008-2021 | 2008-2021 |
| Accident Type | Direct & Indirect | Direct Only | Indirect Only | Direct & Indirect | Direct & Indirect | ABYC Unrelated |
| $\hat{\delta}_i$ (NMMA-Certified) | -0.109<br>(-0.193, -0.026) | -0.042<br>(-0.208, 0.124) | -0.148<br>(-0.247, -0.048) | -0.037<br>(-0.128, 0.053) | -0.059<br>(-0.167, 0.050) | 0.368<br>(0.020, 0.712) |
| Stat. Sig. | * | | ** | | | * |
| Odds Ratio (RAIR) | 0.897<br>(0.825, 0.975) | 0.959<br>(0.812, 1.132) | 0.863<br>(0.781, 0.953) | 0.963<br>(0.880, 1.055) | 0.943<br>(0.846, 1.051) | 1.446<br>(1.020, 2.037) |
| % Change in Odds | -10.328<br>(-17.515, -2.519) | -4.103<br>(-18.783, 13.177) | -13.723<br>(-21.898, -4.695) | -3.678<br>(-12.047, 5.490) | -5.686<br>(-15.382, 5.128) | 44.56<br>(2.039, 103.707) |
| Control Variables | | | | | | |
| Boat Type | | | | x | x | x |
| Boat Length | | | | x | x | x |
| Operator Experience | | | | | x | x |
| Operator Age | | | | | x | x |
| Observations | | | | | | |
| No. Boats | 10,442 | 2,603 | 7,387 | 10,313 | 6,671 | 1,333 |
| No. Boats, NMMA | 5,246 | 1,144 | 3,892 | 5,187 | 3,307 | 883 |
| No. Boats, NMMA with >0 Non-Fatal Injuries | 1,529 | 362 | 1,114 | 1,520 | 1,109 | 780 |

**Notes:** All models estimated using logistic regression per equation (4) in the main text. See Table 2 for a description of direct and indirect accident types, and the main text for more details about the control variable construction. 95% confidence intervals provided in parentheses. Statistical significance where p<0.001=***, p<0.01=**, and p<0.05*.

## 4.3 Boat Recalls

### 4.3.1 Methods

To assess whether boats built to ABYC's standards are less likely to be recalled, we perform a basic comparison of the frequency of recalls and recalled units among NMMA-certified and non-certified boats using the data described in Section 3.3. Limitations of the data available in USCG's recall database prevent the use of more robust statistical inference techniques. Even the interpretation of our descriptive statistics is subject to significant constraints described in the section that follows.

### 4.3.2 Results

Table 7 reports a comparison of the frequency of boat recalls by boat model year and overall. When simply comparing the number of recalls in the USCG's database across NMMA and non-NMMA members across boats with model years 2008 through 2022, we find that NMMA members are associated with the minority of recorded recalls (117 of 364 total, 32 percent). For comparison, we estimate that approximately 11 percent of all boat manufacturers were NMMA certified for model year 2021.[25] Taken together, NMMA members appear *overrepresented* among recalls.

When performing the same assessment on the number of recalled units from model years 2008 through 2022, we similarly find that NMMA members are associated with fewer recalled units than non-NMMA members (193,118 of 594,835 total, 32 percent). In this case, NMMA reports that boats certified in its program comprise over 85 percent of the market for recreational boats (NMMA 2018). Given the NMMA-certified portion of the market is significantly greater than the NMMA-certified portion of recalled boat units, NMMA-certified boats are *underrepresented* in the recall data. In other words, non-NMMA certified boats are more likely to be recalled across the 15 years included in the sample.

Table 7 also presents the comparison of these frequencies by model year. For the number of recalls, our analysis finds that NMMA members are associated with fewer recalls for every model year from 2008 to 2022. For the number of recalled units, NMMA members have fewer recalled units in 11 of 15 of the years included in the assessment.

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[25] Boat production data from Info-Link identifies 958 MICs in the 2021. Of those, 102 are NMMA certified manufacturers.

Table 7. Recall Frequency and Size by NMMA Certification Status

| Boat model year | Number of Recalls | | Number of Recalled Units | |
|---|---|---|---|---|
| | Non-NMMA | NMMA | Non-NMMA | NMMA |
| 2008 | 23 | 17 | 51,128 | 122,466 |
| 2009 | 34 | 4 | 67,105 | 2,499 |
| 2010 | 13 | 8 | 5,702 | 3,705 |
| 2011 | 22 | 4 | 22,126 | 249 |
| 2012 | 8 | 3 | 4,470 | 8,685 |
| 2013 | 5 | 3 | 2,231 | 14 |
| 2014 | 15 | 6 | 111,727 | 1,949 |
| 2015 | 17 | 7 | 14,465 | 2,352 |
| 2016 | 18 | 9 | 3,727 | 6,202 |
| 2017 | 24 | 6 | 75,991 | 12,491 |
| 2018 | 18 | 13 | 2,239 | 8,469 |
| 2019 | 20 | 16 | 16,163 | 6,020 |
| 2020 | 13 | 10 | 6,617 | 2,462 |
| 2021 | 14 | 9 | 17,614 | 15,192 |
| 2022 | 3 | 2 | 412 | 363 |
| **Total** | **247** | **117** | **401,717** | **193,118** |
| **Percent of total** | **68%** | **32%** | **68%** | **32%** |

**Source:** IEc analysis of recall data provided by USCG via email on May 19, 2022. See Section 3.3 for details.

**Notes:** Pink shading denotes specific model years instances where the statistics are higher for NMMA-certified manufacturers.

There are several important data constraints that limit our confidence in the interpretation of these findings:

1. ***Non-NMMA columns may include PWCs or other boat types not subject to ABYC's standards.*** As described in Section 3.3, many entries in USCG's recall database do not identify a boat type. While we exclude entries that are explicitly marked as PWCs, we are unable to detect all recalls associated with PWCs as well as other boats that are outside the scope of ABYC's standards (i.e., rafts and SUPs). Because removing all cases without a boat type specified would restrict the database to very few entries, we include all recalls with non-identified boat types. As a result, it is possible that some of the recalls tagged as "Non-NMMA" are among boats ineligible for NMMA certification.

2. ***Reported frequencies include both safety and administrative recalls.*** Table 7 presents the frequency of all recall types, including both administrative and safety related (see Section 3.3 for more details). Lacking the ability to differentiate between the recall types, we are unable to conclude that NMMA certified boats are less likely to be recalled for safety reasons specifically.

3. ***Reporting inconsistencies in number of recalled units.*** The number of recalled units in Table 7 presents the total across data in the USCG's recall database. However, there are many boat recalls in the database with missing information in this field. Any conclusions drawn from the differences in number of recalled units may be invalid given the presence of zero values in the data.

While the USCG recall database is the best available data source on recalls, it is imperfect in its current format for providing more definitive evidence that boats built to ABYC's standards are less likely to be recalled for safety reasons. Therefore, this analysis is unable to confirm or deny the existing claim that NMMA certified boats are seven times less likely to be recalled by the USCG for a safety issue (see Section 2 for citation).

## 4.3 Summary of Results

Using a QIE modeling framework, our analysis provides strong support that ABYC's voluntary standards (proxied using NMMA certification) reduce the frequency of focused boating accidents, the type of accidents the standards are designed to address. This result is robust across models, although the magnitude of the effect varies with the use of control variables. Together, our results suggest that ABYC's standards reduce the risk of involvement in focused accidents by 43 to 47 percent.

We also provide evidence that the risk of fatalities decreases on these same focused accidents. The models suggest that ABYC's standards reduce the likelihood of a fatality during a focused boating accident by 26 to 58 percent. In other words, not only are these accident types less frequent among NMMA certified boats, but the likelihood of a fatality on those boats during accidents also is reduced. We do not find robust evidence of decreased risk of non-fatal injuries and offer several reasons why the data and modeling approach may contribute to these null results.

Finally, a descriptive analysis of available recall data demonstrates that NMMA certified boats are less likely to be recalled than non-NMMA certified boats. However, limitations in the recall data prevent the interpretation of these relative frequencies as additional evidence that boats that meet ABYC's standards are safer.

# 5. Applying Results in Regulatory Analysis

As described in Section 2, one of the main objectives of this analysis is to provide information to USCG that could support the quantification of benefits for potential future proposed rules designed to align the recreational boating regulations with ABYC's standards. The remainder of this section offers step-by-step guidance on how a USCG analyst could use the results of the effectiveness analysis alongside other information available to USCG to estimate the benefits of such rulemakings. As described in Section 4.3, our analysis provides the strongest support for a reduction in the probability of a focused boating accident and fatalities during those accidents.

Therefore, the guidance below is specific to the monetization of those outcomes. To provide an illustration of how to apply the following steps, we consider a hypothetical rule that aligns the CFR with ABYC's requirements for fuel standards (i.e., priority change 2 from Table 1).

#### Step 1: Determine accident type most likely to be avoided by the proposed rule

USCG first will need to determine which accident types are most likely to be avoided by the proposed rule. For instance, for the hypothetical rule targeting fuel system requirements, USCG will need to select the accident events and causes in BARD most likely to be reduced from these changes specifically. Most likely, the accident types relevant to a specific rule will be a subset of the types included in the focused accident category used in this analysis. For demonstration purposes, we assume that a proposed rule targeting fuel systems would affect "fire/explosion (fuel)" accident events. If a rule includes a broader scope that aligns all relevant portions of the CFR with ABYC's standards, then an analyst may choose to consider all focused accident types identified for this analysis.

#### Step 2: Identify the baseline consequences of relevant accidents

A proposed rule that aligns the current recreational boat manufacturing rules with ABYC's standards will affect any boat builder *not compliant* with the standards. In this memorandum, we assume NMMA-certified builders meet ABYC's standards, although we acknowledge that some manufacturers choose to build to the voluntary standards without seeking NMMA certification.[26] If USCG also uses NMMA certification status as a proxy for current alignment with ABYC's standards, then a rule would affect non-NMMA certified manufacturers and boats, and therefore accidents among non-NMMA certified boats.

As conveyed in Section 3.1, identifying non-NMMA certified boats involved in accidents from BARD requires significant effort. Instead of engaging in such a matching exercise for each potential future rulemaking, Table 8 can serve as a reference to determine the portion of historical accidents associated with non-NMMA certified boats by accident event and accident cause. This table separately presents the portion of accidents associated with 1) non-NMMA boats with model years 2008-2021 (when NMMA certification required compliance with ABYC's standards and 2) all boats with model years before 2008 (when compliance with ABYC's standards is not known because NMMA's certification program did not exist).[27] Importantly, this table highlights the portion of accidents that involved non-NMMA boats over a specific timeframe (2008 to 2021), and these portions are likely to change in the future as older boats are retired and the mix of NMMA certified boat builders changes. So, while Table 8 serves as a convenient reference, USCG may determine at some future date that the data underlying the calculations no longer accurately represents the distribution of boats involved in accidents.

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[26] In IEc (2022), we additionally assume that all manufacturers that are part of buying groups are likely to meet ABYC's standards given the need to bulk-purchase parts. If USCG was interested in using similar assumptions, see that analysis for methods and data sources.

[27] Because our analysis only considers *primary* accident events and causes, Table 8 undercounts potentially relevant accidents. Specifically, it excludes accidents where *secondary* or *tertiary* events and causes are recorded, and one or more of these additional events or causes is the focus of ABYC's voluntary standards. Therefore, a benefits assessment that relies on Table 8 is conservative, in that it is more likely to understate than overstate benefits.

Table 8. Portion of Boating Accidents in BARD (2008-2021) Involving Only Non-NMMA Certified Boats

| Accident Events Directly Related to ABYC's Standards | Percent of Accidents Involving Non-NMMA Boats Model Years 2008-2021 | Percent of Accidents Involving Non-NMMA Boats Model Years <2008 | Accident Causes Directly Related to ABYC's Standards | Percent of Accidents Involving Non-NMMA Boats Model Years 2008-2021 | Percent of Accidents Involving Non-NMMA Boats Model Years <2008 | Accident Events Indirectly Related to ABYC's Standards | Percent of Accidents Involving Non-NMMA Boats Model Years 2008-2021 | Percent of Accidents Involving Non-NMMA Boats Model Years <2008 |
|---|---|---|---|---|---|---|---|---|
| Flooding/swamping | 6.8 | 85.5 | Machinery failure | 6.1 | 84.8 | Person ejected from vessel | 16.8 | 67.9 |
| Capsizing | 30.1 | 63.4 | Improper loading | 14.8 | 75.8 | Collision with recreational vessel | 10.9 | 70.6 |
| Grounding | 9.6 | 73.1 | Equipment failure | 6.6 | 86.4 | Collision with fixed object | 14.9 | 67.8 |
| Person struck by propeller | 6.5 | 74.8 | Overloading | 10.2 | 81.5 | Falls overboard | 13.79 | 70.7 |
| Sinking | 0.0 | 100.0 | Hull failure | 5.4 | 89.4 | Collision with submerged object | 12.5 | 70.9 |
| Fire/explosion (non-fuel) | 4.3 | 86.6 | Ignition of spilled fuel or vapor | 2.5 | 89.8 | Collision with floating object | 14.0 | 69.3 |
| Fire/explosion (fuel) | 2.3 | 91.7 | Inadequate onboard navigation lights | 10.1 | 71.6 | Collision with vessel | 0.8 | 98.5 |
| Fire/explosion (unknown origin) | 6.6 | 85.1 | Failure to vent | 0.3 | 97.0 | Collision with commercial vessel | 17.7 | 71.2 |
| Carbon monoxide exposure | 3.8 | 91.4 | Carbon monoxide exposure | 0.0 | 92.6 | Collision with governmental vessel | 14.6 | 63.2 |
| Electrocution | 0.0 | 81.8 | Off-throttle steering loss | 0.0 | 0.0 | | | |

**Source:** IEc analysis of BARD data.

**Notes:** This table only considers primary accident events and primary accident causes as recorded in BARD. Off-throttle steering loss is not observed as a primary cause in BARD for the subset of BARD accidents described in this table. An accident in BARD is identified by at least one event and one cause. Therefore, the same accidents are included in events columns and the cause columns. Percentages for events and causes are not additive.

We suggest applying this information following three intermediate steps (Table 9 presents this calculation):

- ***Step 2A: Identify the consequences of all accidents for the relevant type in BARD.*** A USCG analyst should filter to the primary event or primary cause identified in Step 1 then report the total number of accidents, fatalities, non-fatal injuries, and property damage across the historical timeframe relevant to the regulatory analysis. For the hypothetical rulemaking, let us assume 60 accidents in BARD from 2008 to 2021 had "fire/explosion (fuel)" as its primary event. The analysis would also record the number of fatalities (3), injuries by severity level (4 minor injuries - AIS Level 1), 12 moderate injuries - AIS Level 2), and approximately $5.8 million in property damage.
- ***Step 2B. Calculate the portion of accident consequences attributable to non-NMMA certified boats.*** USCG analysts can use Table 8 to identify which portion of the total accidents observed in BARD over the same time horizon (2008 to 2021) may be affected by a given rulemaking. Consider again the hypothetical rule that addresses accident events marked as "fire/explosion (fuel)." Table 8 shows that approximately 94 percent of the accidents associated with this event type were among non-NMMA certified boats only, including 2.3 percent among boats with model year 2008 or more recent and 91.7 percent among boats with model year prior to 2008. For this illustrative example, we will consider all of these boats to be potentially affected by a future regulation, although USCG may make different assumptions. An analyst would multiply the consequences of accidents in Step 2A by 94 percent to arrive at the non-NMMA portion. In this example, we calculate 56.4 accidents associated with 2.8 fatalities, 3.8 minor injuries, 11.3 moderate injuries, and approximately $5.5 million in property damage. These outcomes should be divided by the number of years represented in the BARD data to calculate the average annual baseline risk. Given our data encompass a 14-year period, this equates to 4 accidents, 0.2 fatalities, 0.3 minor injuries, 0.8 moderate injuries, and approximately $390,000 in property damage per year in accidents among non-NMMA certified boats.
- ***Step 2C. Adjust for underreporting to BARD.*** Importantly, it is well-known that non-fatal injuries and property damage are underreported to BARD (IEc 2011, 2023). To correct for this underreporting, an analyst should apply the underreporting multipliers suggested in IEc (2023) to the calculated non-fatal injuries and property damage amounts.[28,29] When applying the multipliers, we calculate annual consequences equivalent to 0.2 fatalities (no multiplier), 32.2 minor injuries (120 multiplier), 1.2 to 96.7 moderate injuries (1.5 to 120 multiplier), and approximately $2.8 million to $8.5 million in property damage (7.27 to 21.77 multiplier). For simplicity, we only report the results applying the low-end of the

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[28] These multipliers include: 120 for minor injuries (AIS Level 1), 1.5-120 for moderate injuries (AIS Level 2), 1.5-1.7 for serious, severe, and critical injuries (AIS Levels 3 through 5), and 7.27-21.77 for property damage. IEc (2023) is accompanied by an Excel-based tool that automatically corrects for the suggested underreporting multipliers.

[29] In some cases, a proposed rule will only apply to a subset of all recreational boats, as opposed to all boats that could meet ABYC's standards. In those cases, USCG will need to further adjust the numbers calculated in these steps to account for the relative portion of all recreational boats subject to the rule. As an example, priority change 4 is specific to boats less than 26 feet. If USCG had additional information about which portion of recreational boats fall into this category, then it would apply that percent to the consequences estimated here.

underreporting multipliers in Table 9 that follows. For a regulatory analysis, an analyst should employ and present the results using both the low- and high-end multipliers.

**Table 9. Example Consequences on Boating Accidents Involving Non-NMMA Certified Boats**

| | Accidents | Fatalities | Injuries (AIS 1) | Injuries (AIS 2) | Injuries (AIS 3) | Injuries (AIS 4) | Injuries (AIS 5) | Property damage |
|---|---|---|---|---|---|---|---|---|
| **Step 2A:** All accidents in BARD (2008-2022)[a] | 60 | 3 | 4 | 12 | 0 | 0 | 0 | $5,800,000 |
| **Step 2B:** Non-NMMA accidents in BARD (2008-2022)[b] | 56.4 | 2.8 | 3.8 | 11.3 | 0 | 0 | 0 | $5,452,000 |
| **Step 2B:** Non-NMMA accidents in BARD (per year)[c] | 4.0 | 0.2 | 0.3 | 0.8 | 0 | 0 | 0 | $389,429 |
| **Step 2C:** Non-NMMA accidents in BARD (per year, with multipliers)[d] | 4.0 | 0.2 | 32.2 | 1.2 | 0 | 0 | 0 | $2,831,146 |

**Sources:**

a. Hypothetical information.

b. Calculated by multiplying the preceding row by 94 percent (i.e., the portion of "fire/explosion (fuel)" accident events that did not involve NMMA certified boats.

c. Calculated by dividing the preceding row by 14 years (i.e., the number of years represented in the BARD data).

d. Calculated by applying the underreporting multipliers from IEc (2023) to the preceding row. For simplicity, in this hypothetical example we employ the low-end multipliers where a range is suggested. For a regulatory analysis, analysts should present low- and high-end estimates.

### Step 3: Apply probability reductions in risk presented in this memorandum

The results presented in this memorandum are directly interpreted as a percent reduction in the probability of a focused accident and fatality during a focused accident. Because our approach pools BARD data across specific accident events, we interpret the model findings as support that ABYC's standards reduce the likelihood of a broad set of accidents directly or indirectly related to the standards. We do not provide separate results by accident event or cause and therefore suggest applying the results from the collective set of accidents to any specific type within the set of direct and indirect accidents. An analyst should consider describing this as a limitation in the benefits assessment or alternatives discussion within the regulatory analysis.

Our results suggest that ABYC's standards confer benefits in two ways: 1) they reduce the probability of an accident and 2) they reduce the presence of fatalities on accidents that occur. In other words, fatalities are reduced both from the reduction in accident frequency as well as the reduction severity among the remaining accidents. Therefore, a benefits assessment should capture both components when estimating the total incremental benefits of a rulemaking by investigating these effects sequentially, as follows (see Table 10 for detail on these calculations):

- ***Step 3A: Apply reduced likelihood of an accident.*** For accident frequency, our preferred models demonstrate that ABYC's standards reduce the likelihood of a focused accident by 43 to 47 percent on NMMA certified boats. The range conveys that the magnitude of our estimates varies with the use of control variables. To continue with our example rule, applying this range of effectiveness measures suggests that aligning the CFR with ABYC's fuel system requirements would result in a reduction of 1.7 to 1.9 accidents annually involving non-NMMA certified boats. The consequences of these events would also be reduced by the same percent reductions, on average. When considering the baseline outcomes of accidents with the low-end underreporting multipliers applied (from Step 2), this means that 0.09 fatalities, 13.9 to 15.2 minor injuries, 0.52 to 0.57 moderate injuries, and $1.2 to $1.3 million in property damage would be avoided.

- ***Step 3B: Apply reduced likelihood of a fatality during an accident.*** For fatalities during focused accidents, the same preferred model specifications show that ABYC's standards reduce the likelihood of any fatalities during focused accidents by 26 to 58 percent. This means that, among the *remaining* baseline accidents that occur, fatalities are reduced. To calculate this additional beneficial effect, we apply the range of effectiveness measures to the difference between baseline fatalities (Step 2) and the reduced number of fatalities from avoided accidents (Step 3A). For presentation purposes, we suggest combining the low-end range of effectiveness estimates in Steps 3A (43 percent) with the low-end effectiveness measure for this portion (26 percent) and presenting the results as a low-end benefits estimate. A similar approach can be taken for the high-end effectiveness estimates (47 percent from Step 3A with 58 percent from this step). For our example rulemaking, this would mean an additional reduction in 0.03 fatalities for the low-end scenario and 0.06 fatalities for the high-end scenario (see Table 9).

- ***Step 3C: Add fatality reductions to determine total reduction in deaths.*** Because reduced fatalities are outcomes of the calculations in both Step 3A and Step 3B, this final step involves adding the fatalities from both effects to determine the total incremental change in fatalities attributable to the rule. Combined with Step 3A, we find that aligning with ABYC's fuel standards results in a total annual reduction of 0.12 to 0.16 fatalities.

Table 10. Example Calculation of Incremental Reduction in Accident Consequences

| | Accidents | Fatalities | Injuries (AIS 1) | Injuries (AIS 2) | Injuries (AIS 3) | Injuries (AIS 4) | Injuries (AIS 5) | Property damage |
|---|---|---|---|---|---|---|---|---|
| **Step 2:** Baseline accident consequences per year[a] | 4.0 | 0.2 | 32.2 | 1.2 | 0 | 0 | 0 | $2,831,146 |
| **Incremental benefits of hypothetical rule (low-end)** | | | | | | | | |
| **Step 3A:** Incremental change due to accident reduction (43%)[b] | 1.73 | 0.09 | 13.86 | 0.52 | 0.00 | 0.00 | 0.00 | $1,217,393 |
| **Step 3B:** Incremental change due to fatality reduction during accidents (26%)[c] | | 0.03 | - | - | - | - | - | - |
| **Step 3C:** Total incremental change in accident consequences[d] | | 0.12 | 13.86 | 0.52 | 0 | 0 | 0 | $1,217,393 |
| **Incremental benefits of hypothetical rule (high-end)** | | | | | | | | |
| **Step 3A:** Incremental change due to accident reduction (47%)[e] | 1.89 | 0.09 | 15.15 | 0.57 | 0.00 | 0.00 | 0.00 | $1,330,638 |
| **Step 3B:** Incremental change due to fatality reduction during accidents (58%)[f] | | 0.06 | | | | | | |
| **Step 3C:** Total incremental change in accident consequences[g] | | 0.16 | 15.15 | 0.57 | 0 | 0 | 0 | $1,330,638 |

**Sources:**

a. See Table 9.
b. Calculated by multiplying the contents of the Step 2 row by 43 percent.
c. Calculated by subtracting the reduced fatalities in Step 3A from the total fatalities in Step 2 (0.2 - 0.09 = 0.11) then multiplying by 26% (0.11 * 26 percent = 0.03).
d. Calculated as the sum of Step 3A and Step 3B.
e. Calculated by multiplying the contents of the Step 2 row by 47 percent.
f. Calculated by subtracting the reduced fatalities in Step 3A from the total fatalities in Step 2 (0.2 - 0.09 = 0.11) then multiplying by 58% (0.11 * 58 percent = 0.06).
g. Calculated as the sum of Step 3A and Step 3B.

### Step 4: Apply values to avoided fatalities and non-fatal injuries

The approach used to value risk reductions in Federal regulatory analyses is determined, at least in part, by guidance issued by OMB to implement Executive Order 12866, as supplemented by Executive Order 13563 (Clinton 1993; Obama 2011). This guidance is contained in OMB's Circular A-4 (2023). The DHS Chief Regulatory Economist provides additional clarification regarding the values to be used in regulatory analyses by component agencies (DHS 2023).

USCG has an existing approach for monetizing avoided fatalities and injuries that can be applied to the numbers calculated in Step 3, and IEc (2023) provides a detailed overview of the values and their derivation.[30] The current values per case include $12.5 million for fatalities, $37,500 for minor injuries (AIS Level 1), $588,000 for moderate injuries (AIS Level 2), $1.31 million for serious injuries (AIS Level 3), $3.33 million for severe injuries (AIS Level 4), and $7.41 million for critical injuries (AIS Level 5) (all in 2022 dollars). Property damage already is expressed in monetized terms. Table 11 presents these current values per case and applies them to the incremental reduction in accident consequences calculated previously for our hypothetical rulemaking.

**Table 11. Example Monetization of Incremental Benefits (2022 dollars)**

| | Fatalities | Injuries (AIS 1) | Injuries (AIS 2) | Injuries (AIS 3) | Injuries (AIS 4) | Injuries (AIS 5) | Property damage |
|---|---|---|---|---|---|---|---|
| Values per case[a] | $12,500,000 | $37,500 | $588,000 | $1,310,000 | $3,330,000 | $7,410,000 | N/A |
| **Incremental benefits of hypothetical rule (low-end)** | | | | | | | |
| Total incremental change in accident consequences[b] | 0.12 | 13.86 | 0.52 | 0 | 0 | 0 | $1,217,393 |
| Monetized incremental benefits[c] | $1,455,825 | $519,686 | $305,575 | $0 | $0 | $0 | $1,217,393 |
| **Incremental benefits of hypothetical rule (high-end)** | | | | | | | |
| Total incremental change in accident consequences[b] | 0.16 | 15.15 | 0.57 | 0 | 0 | 0 | $1,330,638 |
| Monetized incremental benefits[c] | $1,957,382 | $568,029 | $334,001 | $0 | $0 | $0 | $1,330,638 |

**Sources:**

a. The current VSL is provided in DHS (2023). The values associated with non-fatal injuries were calculated following USCG's standard approach that applies multipliers to the VSL for each AIS level.

b. Step 3C, see Table 10.

c. Calculated by multiplying the preceding row by the "values per case."

### Step 5: Calculate total incremental benefit of regulatory action

Finally, to calculate the rule's incremental benefits, as captured by reduced boating accident frequency and severity, an analyst would sum across the values associated with avoided fatalities, non-fatal injuries, and property damage. For our hypothetical fuel systems rule, the incremental safety benefits of the rule are valued at $3.5 million to $4.2 million annually (2022 dollars). The approach described above considers the safety-related benefits of the rule, specifically captured through the reduction in risk of boating accidents. An analyst also should consider if a rule aligning the CFR with ABYC's standards may have other benefits as well (e.g., ecological).

[30] We note that IEc (2023) presents the values per case in 2020 dollars while this memorandum relies on the most current guidance, which is denoted in 2022 dollars.

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## Appendix: Simulations for QIE Approach

The QIE results presented in Section 4.1 suggest a significant negative relationship between NMMA certification and the risk of involvement in a focused set of accidents where NMMA certified boats are seen as safer than non-NMMA certified boats. However, the validity of this finding is contingent on the key assumption of the QIE method being met—namely that the "control" accident type (i.e., the non-focused accidents) is genuinely independent of NMMA certification. Given the data limitations that require us to use QIE analysis in the first place (i.e., the lack of exposure data for all recreational boats), we cannot obtain the data necessary to fully test this assumption empirically. To explore the ramifications for our QIE analysis if this assumption is not met, we conducted an analysis of simulated data allowing for the observation of exposure for both NMMA certified and non-NMMA certified boats to both the focused accident type and the non-focused accident type. In the analysis of the simulated data, we explored how results of a QIE analysis on a subset of a data set would differ from those of a traditional, exposure-based analysis of the whole data set.

We first simulated 9 different samples of simulated data representing every combination of boat certification being positively associated with, negatively associated with, or independent of both the focused set of accidents and the non-focused set of accidents, assuming a NMMA boat certification level of 52.5 percent which was consistent with the analysis dataset. Additionally, because NMMA believes that the percentage of recreational boating boats that meet the NMMA certification standards is likely higher than the 52.5 percent observed in our data, we repeated the 9 different samples of simulated data assuming a higher NMMA certification level for boats (80 percent). Each of the 18 simulated samples contained 500,000 observations of simulated boat trips. In the first 9 samples, whether a boat was NMMA certified was determined by a random draw with 52.5 percent probability of being a certified boat and a 47.5 percent probability of not being certified. In the second 9 samples, these probabilities were 80 percent and 20 percent respectively. Indicators of whether a given trip ended in a focused accident or a non-focused (control) accident were randomly drawn from binomial distributions with different levels of risk. The risk of a focused accident was set as 0.05 (or 5 in 100 trips) for the conditions in which the accident was assumed to be independent of NMMA certification, 0.05 * (1.5) for the conditions in which accident involvement was assumed to be positively associated with NMMA certification, and 0.05 * (1/1.5) for the conditions in which accident involvement was assumed to be negatively associated with NMMA certification. The risk of the non-focused (control) accident was set at 0.005, 0.005 * (1.5), and 0.005 * (1/1.5) for conditions where control accidents were independent of, positively associated with, and negatively associated with NMMA certification.

We then analyzed the relationship between NMMA certification and focused accident risk in each of the simulated data samples using logit regression with the focused accident indicator as the dependent variable and NMMA certification as the independent variable. First, exposure-based analysis was carried out via logit regression of the full sample. Second, QIE analysis was carried out via logit regression of the subsample of trips that ended in either a focused accident or a non-focused (control) accident. This mimics the real-world conditions under which QIE is used, when data on accidents is available but data on non-accident exposure is not. Because the exposure-based analyses return unbiased estimates of the relationships between NMMA certification and focused accident risk, comparison between the results of the exposure-based analysis and the QIE analysis shows the conditions under which the QIE analysis results are biases and unbiased.

Table A.1 presents the results of the analysis of the 18 different simulated samples representing different assumptions about the relationships between NMMA certification and focused and non-focused (control) accidents.

As can be seen in the table, when NMMA certification is independent of control accident risk, the QIE analysis results are virtually identical to the exposure-based analysis results, showing that in that case, the QIE results are unbiased. This finding is fully in line with our assumptions about the need for the control accident to be independent of the independent variable in QIE analysis. However, when NMMA certification is negatively related to control accident risk, the QIE analysis results are biased upward, such that the relationship between NMMA certification and focused accident risk appears more positive in the QIE analysis than in the exposure-based analysis. And when NMMA certification is positively related to control accident risk, the QIE analysis results are biased downward, such that the relationship between NMMA certification and focused accident risk appears more negative in the QIE analysis than in the exposure-based analysis.

Given that we observe a significant negative relationship between NMMA certification and focused accident risk in the QIE analysis of our real-world data, if the risk of control accidents was actually negatively related to NMMA certification, our reported results would be conservative and the true relationship between NMMA certification and focused accident risk would be even more strongly negative than what we report. In this case, the magnitude of the relationship we report in the main analysis may be conservative, but the direction of this relationship would remain correct. On the other hand, if the risk of control accidents was positively related to NMMA certification, our reported results could be completely spurious in that a false relationship between NMMA certification and focused accident risk could be created by the QIE methodology in this case. Thus, the greatest threat to the validity of the reported results is the possibility of a positive effect of NMMA certification on the risk of the control, non-focused accidents for which NMMA certification to ABYC standards should not have an impact.

We remain convinced that it is most likely that the occurrence that non-focused accidents are indeed independent of NMMA certification since the set of non-focused accidents were those for which experts thought ABYC standards could not impact. However, even if this logic is inaccurate and NMMA certification does impact these non-focused accidents, it is highly unlikely that there would be a positive effect in that the safety features of NMMA certification would make non-focused accidents more likely. Thus, the simulation results suggest that even if the assumptions we made in conducting our QIE analysis do not fully hold, the most likely result would be that the reported QIE results are somewhat conservative in magnitude, but correct in direction, rather than completely spurious.

Table A.1. Results of Analysis of Simulated Data

| Condition | Fraction NMMA Certified | Exposure Coef. | p-value | QIE Coef. | p-value | QIE Sample size |
|---|---|---|---|---|---|---|
| Focused = Independent, Non-Focused = Independent | 52.5% | 0.005 | 0.709 | 0.039 | 0.360 | 27,358 |
| Focused = Negative, Non-Focused = Independent | 52.5% | -0.408 | 0.000 | -0.437 | 0.000 | 23,128 |
| Focused = Positive, Non-Focused = Independent | 52.5% | 0.422 | 0.000 | 0.453 | 0.000 | 33,754 |
| Focused = Independent, Non-Focused = Independent | 80.0% | -0.009 | 0.587 | -0.065 | 0.231 | 27,266 |
| Focused = Negative, Non-Focused = Independent | 80.0% | -0.425 | 0.000 | -0.449 | 0.000 | 20,715 |
| Focused = Positive, Non-Focused = Independent | 80.0% | 0.464 | 0.000 | 0.461 | 0.000 | 36,979 |
| Focused = Independent, Non-Focused = Negative | 52.6% | -0.009 | 0.468 | 0.336 | 0.000 | 27,091 |
| Focused = Negative, Non-Focused = Negative | 52.5% | -0.401 | 0.000 | 0.026 | 0.579 | 22,467 |
| Focused = Positive, Non-Focused = Negative | 52.5% | 0.424 | 0.000 | 0.800 | 0.000 | 33,514 |
| Focused = Independent, Non-Focused = Negative | 80.0% | -0.009 | 0.587 | 0.337 | 0.000 | 26,622 |
| Focused = Negative, Non-Focused = Negative | 80.0% | -0.422 | 0.000 | 0.038 | 0.492 | 20,034 |
| Focused = Positive, Non-Focused = Negative | 80.0% | 0.407 | 0.000 | 0.766 | 0.000 | 36,500 |
| Focused = Independent, Non-Focused = Positive | 52.5% | 0.001 | 0.923 | -0.413 | 0.000 | 28,034 |
| Focused = Negative, Non-Focused = Positive | 52.6% | -0.415 | 0.000 | -0.769 | 0.000 | 23,678 |
| Focused = Positive, Non-Focused = Positive | 52.5% | 0.422 | 0.000 | 0.040 | 0.315 | 34,760 |
| Focused = Independent, Non-Focused = Positive | 79.9% | -0.004 | 0.788 | -0.500 | 0.000 | 28,374 |
| Focused = Negative, Non-Focused = Positive | 80.0% | -0.439 | 0.000 | -0.861 | 0.000 | 21,618 |
| Focused = Positive, Non-Focused = Positive | 80.0% | 0.428 | 0.000 | -0.022 | 0.673 | 38,169 |

**Notes:** Exposure Coef. stands for the coefficient of NMMA certification in the exposure-based analysis. QIE Coef. stands for the coefficient of NMMA certification in the QIE analysis.