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The Great Lakes Insurance Company

A Major Qualifying Project Report
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Abstract:

This project researches the process an insurance company goes through to price boat insurance. Gathering data from boating statistics and insurance companies, a simulation product is created, utilizing accident rates, expected losses, and operator characteristics. This new product offers personal property, liability, and medical protection; as well as a unique policy for death benefits. Assuming realistic conditions like regional factors, business expenses, and projected customer base; the resulting insurance policy is both profitable and competitive in real life situations.

Chapter 1: Introduction

There are a variety of different types of insurance in the United States. Some of them are similar among all states, such as health insurance, where the living conditions are generally similar. Others are affected by regional differences, which mean that some types of insurance may either be inapplicable or have very poor business opportunities in certain states. Boat insurance belongs to the latter type because it is only becomes profitable when sold in states that either borders an ocean, or contain many lakes. The purpose of this project is to price a new insurance product that is both unique and affected by regional factors. Boat insurance not only fits these characteristics, but also has a large pool of potential clients to draw from.

Since boat insurance is a regional service, careful decisions have to be made in order to decide which states to cover. By analyzing the boating statistics for the popular boating states from the United States Coast Guard, the top five states in the nation with the most registered boats are Florida, California, Minnesota, Michigan, and Wisconsin. The number of accidents for each state is divided by its total registered boats to give the state wide accident rates. It is immediately noticeable however, that although Florida and California have the largest population of boaters, they also have significantly higher accident rates than most of the other states. The other top boating states; Minnesota, Michigan and Wisconsin; all Great Lake states, yielded much better results. Upon further study, it is discovered that all of the Great Lake states are within the top 10 boating states of the U.S. Along with low accident rates, all of these states provide the advantage of a regional business for lower expenses. With the addition of Illinois, Indiana, and Ohio, these states are finalized as the region covered by the simulated company named "The Great Lakes Insurance Company."

The most important and difficult part of developing a new insurance product is to determine the pricing formula because a large amount of data is necessary in order to analyze the relationships between all of the inputs. It becomes crucial to have years of detailed historical data in order to predict future risks and trends. Depending on the different demands that customers might have, mathematical equations must be created to calculate the pricing formulas for all available options.

For the Great Lakes Insurance Company (GLIC) four basic coverage options are made available: physical damage, liability, medical coverage and death benefits. In the following chapters, each section will be thoroughly discussed to show the steps taken in reproducing an insurance quote.

Chapter 2: Background

Description of boat insurance:

The insurance industry can be separated into two major categories; Life & Health and Property & Casualty. Life & Health protects against financial loss in the event of injury, sickness, or death. Property & Casualty on the other hand, focuses on providing insurance against the loss of real property, tangible assets and income. Boat insurance belongs to Property and Casualty. Similar to automobiles, boats are vulnerable to accidents, bad weather, and theft. According to information from the USCG, the number of boating deaths, injuries and property damage has been increasing since 2005. In order to protect the boat and its passengers and avoid significant financial loss, it is important to purchase boat insurance.

Boats can be classified in seven groups: Powerboats, sailboats, houseboats, personal watercrafts, performance boats, charter boats and mega yachts. Since various different coverage options are available for each type of boat, it may be complicated for boat owners to choose the best type of insurance to suit their needs. Important awareness factors for boat owners are detailed in the coverage policy, such as procedures for towing and grounding. Insurance agents will help the customers determine the best and most affordable coverage for their situation.

Before purchasing boat insurance, the company will provide the customer with an insurance quote to estimate how much their coverage options will cost them on a yearly basis. Generally, the cost of insurance will depend on several factors:

- Total boat value
- Size and length
- Age
- Boat type
- Engine power
- Mooring Location
- Deductible

Factors such as deductibles, area of navigation, installation of safety devices, and official training may reduce the cost of premiums.

Standard boat insurance is divided into three broad categories:

1. Physical Damage provides payment when boats are damaged or destroyed by a covered peril, such as collision, fire, theft, windstorm, and vandalism. Coverage can extend to auxiliary equipment, outboard motors, trailers, and personal property.
2. Liability provides protection in the event of a legal issue. If a customer is sued and/or held legally responsible for damages to

property or injury to someone other than themselves or a family member, they may rely on liability coverage.

3. Medical coverage provides protection for reasonable medical, ambulance and hospital fees for someone who is injured while in, on, while boarding, or leaving your boat.

While the most expensive coverage is generally not necessary for everyone's needs, it is important to understand the potential risks in order to balance between insurance price and coverage.

Risks

Boating has become increasingly popular over the decade. As with any popular activity involving people, power equipment, and water, there are many risks involved. These boating risks include and are not limited to:

- Damage to the boat from fire, explosion, or collision with other vessels or objects.
- Injury or death of passengers in the boat, being pulled by boat, or in the water.
- Injury or death caused by Carbon Monoxide Exposure, Falls in/on Boat, Flooding/Swamping and so on.
- Damage to other boats and injury of other people.
- Damage to docks
- Pollution of land or water by petroleum products spilled from the boat.
- Theft or other crimes that might take place on a boat.

According to the *Boating Statistics 2006* published by The U.S. Department of Homeland Security and The USCG, the three types of accidents that are most likely to result in a fatality are:

1. Capsizing & fire/explosion (cause of most property damage)
2. Collision with another vessel
3. Skier mishap

With only the reported accidents in 2006, there are over 3400 injuries, and the fatalities numbering in the 700s. Total reported property damages cost over 43.5 Million Dollars.

There are two ways of dealing with risk. First, it is important to know how to control the risk. Boats should be equipped with proper safety equipment such as radios, flares, spare batteries, personal flotation devices, fire extinguishers, etc. Secondly, boat operators should receive safety training, and should review the state and federal boating laws.

Getting a Quote

Getting a free boat insurance quote online is an easy process. However, different companies may have different pricing policies. Normally, the insurance company requires the inquirer to provide some relevant information during the quoting process. For example, Progressive requires four pages of different questions to be answered in order to receive a price quote. These questions generally include details such as:

- The location of boat
- Experience of the operator
- Levels of coverage
- Whether the customer has purchased insurance from that company before.
- When the operator will use their boat the most (month)
- Number of secondary operators

After looking through the different questions that companies ask in order to offer a quote, a logical deduction of necessary factors in the pricing process can be made. By utilizing the information required by these companies as a guideline, a mathematical model can be created to simulate similar pricing methods.

Chapter 3: Data Process

The major source of data used in this project is from the boating statistics created by the United States Coast Guard, which can be found from their website http://www.uscgboating.org. The USCG has published annual statistics about registered boats, accidents, injuries, fatalities, causes, and property damage each year since 1997. However, in order to utilize trends and predict future outcomes, the most relevant data are the statistics from 2001 to 2006 as they have recently expanded the amount of data they record.

The recent data is generally believed to be more accurate, but it is also possible that there are special circumstances in certain years that cause inaccurate data, such as natural disasters and economical crises. In order to account for these inconsistencies, it is necessary to use an average of all applicable data from recent years. This is also helpful because it increases the size of the data pool. The additional data allows for a more detailed calculation of averages. To properly account for data over several years, all calculations are taken using weighted averages to place emphasis upon more recent years. In the sections for Medical Payments and Liabilities, the averages are calculated using the equation:

*Average = (2006*6 + 2005*5 + 2004*4) / 15*

In some special cases, data from as far back as 2001 is utilized. Similar to the equation above, the average is calculated by:

*Average = (2006*6 + 2005*5 + 2004*4 + 2003*3 + 2002*2 + 2001*1) / 21*

Although the boating statistics reports are made professionally, they are not accurate enough due to the vast majority of accidents that remain unreported. Unreported accidents almost never include fatalities as these are naturally reported due to their severity. In many cases, boaters don't realize they have the obligations to report all accidents. Generally, unreported accidents are resolved privately by the parties involved and do not involve the authorities or the insurance companies so it is very difficult to estimate how big this number actually is. In all available data sources and articles that have been under review, it is only described as "the vast majority". Due to the ambiguity in this area, an estimate is created based on the verbal breakdown of what a vast majority might actually represent.

A majority is used to describes the largest portion of a sample population so unreported accidents have to account for more than 50% of all accidents. Therefore a vast majority should mean an overwhelming difference between reported and unreported accidents such as from 1%-10% of accidents being reported. From a later interview with a representative of USCG, they said the proposed estimate of 95% of all accidents going unreported is not unreasonable. For real insurance companies, more data would be available. By collaborating and/or purchasing data from other companies and organizations, a more detailed estimate can be made. Another possibility is taking real insurance data accumulated from past years to support new projections.

Sometimes it can be hard to perform calculations based purely on boating statistics. For example, there is no data concerning the cost of certain injuries, which makes it impossible to find out the price of medical payments. But it’s possible to utilize free information provided by other insurance companies. Companies such as Progressive and Boat U.S. provide guides in the form of their free quote services. These descriptions are in turn logically broken down to understand the basics of the insurance calculations for certain areas such as medical and liability. By submitting a diverse pool of different available factors into their calculators, a reconstruction of their formulas can be made and tailored to the options that the GLIC have created. It is through the reverse engineering of professional insurance calculations that the Medical and Liabilities sections are created.

Summary of Equations

The following equations are used to calculate the expected losses per year for each coverage option. These equations will be explained in more detail in the later sections.

List of Variables:

- L = losses
- C = accident rate
- OR = operator risk
- BR = boat risk
- BV = boat value
- AL = average liability loss
- IR = injury rate
- AM = average medical loss
- E = expenses
- D = deductible
- FR = fatality rate = yearly death rate under optimal conditions
- W= used in winter
- ML = medical limit level(1-5)

Personal Property Damage:

L_P=C [(0.40) (OR) (BR) (BV)-D] + E

Liability:

L_L=C [(OR) (AL)-D] + E

AL_{PWC}=average liability loss for PWC

AL_{MB}=average liability loss for motorboat

Medical Payments:

L_{mp} = (IR) (AM) (ML) + E

Death Benefits:

L_{DB} = (FR) (W) (OR) (50,000)

W=1 if not used in winter, W=1.76 if used in winter.

Chapter 4: Expenses

The pricing model that GLIC utilizes incorporates the expected loss per contract plus the expenses before a profit margin is calculated. Therefore, calculating expenses are very important in determining the final price of the insurance product. These expenses apply not only towards the insurance payments for accidents, but to ordinary expenses that a company accrues throughout the course of the year. The expenses such as rent, utilities, wages, appliances & furniture, computers and maintenance are all factored into the pricing formula for insurance. The goal of the Great Lakes Insurance company is to minimize the expenses associated with running a business in order to present a move competitive price to the customers.

Although many of the finer details in a real company have been omitted, the assumed expenses for the Great Lakes Insurance Company are grouped within two categories: Fixed Expenses and Variable Expenses. Although loosely defined as opposed to its real life counterpart, these expenses weigh in practical assumptions and reasonable needs. All expenses are divided evenly between an expected customer base of 200,000 people, which is only 6% of the market in these states. With competitive pricing and many regional offices that GLIC has spread around all six states, this is a modest estimate. In real life, an assumption of 10-15% of the market will be ideal for a larger company, as there aren't many insurance companies selling boat insurance. Also, as the customer base grows, both variable and fixed expenses are reduced.

Fixed Expenses are the overhead of a company. These expenses include rent, electricity, and appliances. Aside from fluctuations in real estate prices, they generally remain the same from year to year. As the customer base grows, the fixed expenses will be reduced. For GLIC, a regional company operating in the Great Lakes area, these expenses are calculated based upon the assumption of one main office and a total of 50 smaller offices spread around the area. The main office will require approximately $150,000 in rent per year while the smaller offices will accrue about $12,000 each. The assumed budget for these expenses is $800,000 a year to account for utilities, office supply deterioration, and rent. This results in an addition of a $4 surcharge per customer with the assumed 200,000 clients. Even with a significantly larger client base, this budget will not see any large changes.

Variable expenses however, are generally much higher. In this case, his category of expenses is defined to cover the employee pool. With 50 offices in the area, the Great Lakes Insurance Company is a small company that houses 600 employees. With an assumed average of around $42,000 a year per employee, this figure is equal to 2.5 Million Dollars. With 200,000 customers, these expenses come to approximately $125 per customer. The variable expenses of $125 are divided by three to achieve a flat rate of $42 per contract and an additional $42 for each of the three main coverage options: Personal Property, Liability, and Medical Payments. A smaller rate of $5 is charged for death benefits. Of GLIC's employee pool, a majority belongs to the sales staff, so with the company's competitive pricing, it is safe to assume most customers will purchase at least two of the three main insurance products to cover these variable expenses. This way, even though not all customers will buy a full insurance package, the variable expenses will not cut into the profits of the company. Although variable expenses will grow depending on the amount of customers, this price will not remain the same. As more customers apply for insurance at the company, the variable expenses will also be lowered, although not as fast as the fixed expenses.

Chapter 5: Operator Risk Calculations

When trying to estimate how risky it is to sell insurance to someone, one of the main concerns of an insurance company is to judge the person they are doing business with. With boat insurance, this applies just as much. Although there are many luck factors that might cause a boating accident, most of the important factors are related to the operator of the vehicle. In most respects this is similar to auto insurance, with a larger road and a greater chance of drowning… Lack of knowledge or irresponsible actions can lead to many types of accidents. Since this is directly linked to the cause of an accident, operator risk is a key determinant in the pricing of boat insurance.

In order to calculate operator risk, many potential characteristics come to mind. The number of factors that are related to the propensity for people to get into accidents is endless. However, the data required to calculate many of these factors are almost non-existent, and therefore beyond the scope of this project. Some pertain able factors are weather, or time of day, which indirectly affects operator risk. Drivers who choose to take their boats out in bad weather or late at night can be expected to be involved in more accidents. However, some of these attributing factors defy numeric measurement. Since there is a limit to the amount of information available, some assumptions have to be made and these factors have to be excluded.

The data pool for this area is not very large. After searching through what is available, the initial proposal is to use three main factors in determining operator risk: experience, age, and boating knowledge. After dividing each category into a finite number of brackets, these three characteristics can divide boat operators into nearly 150 different risk categories.

OPERATOR INFORMATION		VESSELS INVOLVED	FATALITIES
TOTALS		6,753	710
AGE OF OPERATOR	12 years and under	33	1
	13 to 18 years	530	30
	19 to 25 years	787	72
	26 to 35 years	994	103
	36 to 55 years	2,133	244
	Over 55 years	729	119
	Unknown	1,547	141
OPERATOR'S EXPERIENCE	Under 10 hours	410	27
	10 to 100 hours	1,331	122
	100 to 500 hours	1,616	121
	Over 500 hours	590	52
	Unknown	2,806	388
EDUCATION OF OPERATOR [1]	Informal	291	18
	None	2,587	253
	Other	350	43
	American Red Cross	34	1
	State Course	538	27
	US Power Squadrons	113	5
	USCG Auxiliary	269	8
	Unknown	2,571	355

[1] Education of operator implies that some safety instruction has been received, but not necessarily that a course was successfully completed.

Figure 1: Accident rates for Operator risk brackets

A fourth condition is created based on the actual personal performance of the driver. Although no data is available to help with the pricing, this aspect is still too important in the pricing process to ignore. This expanded the number of operator risk categories to more than 3000 allowing for a list of applied weights to categorize a realistic variety of customers.

Figure 1 is just one of the six different years of data that is used to price the risk. When parameters are calculated for the pricing model, regression analysis is implemented to see any trends in the data. This is later graphed for visual observation. A weighted average is determined for each bracket based on year with a condition of importance based on more current years. Here's an example of a fairly drastic trend in the accident rate for people with 101-500 hours of experience:

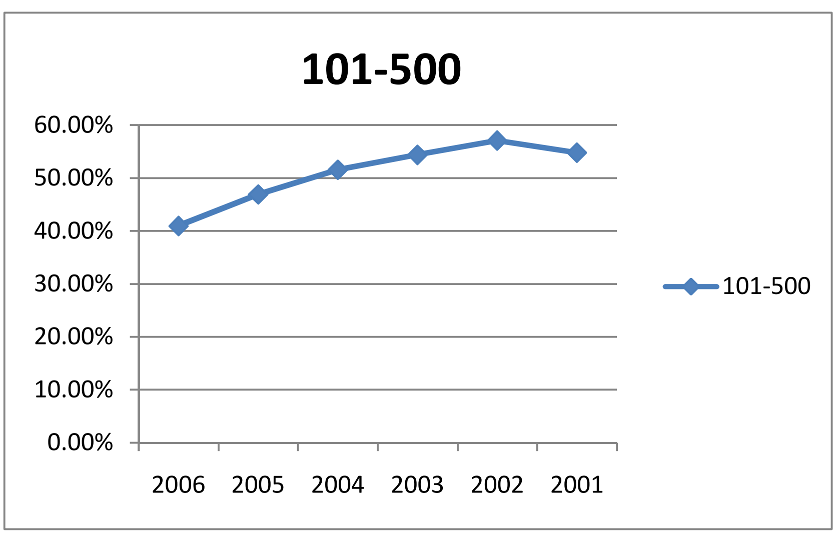


Figure 2: percent of total accidents for a bracket in Experience

The percentiles in the Y axis represent the percentage of total accidents that is accrued by people with 101-500 hours of boating experience during the year. Although this is a fairly large number, consideration is placed upon the total number of drivers that fit in this category in order to calculate the risk. If the final risk calculation is over 100%, which is the risk for an average driver, they will end up having to pay a heftier premium.

Another consideration is using projected percentages in order to calculate what the expected accident rate for the following year is going to look like. In this case, it is fairly easy to guess that the accident rate for next year will go down to 40% or lower but there are several brackets which have fairly complicated trends or none at all:

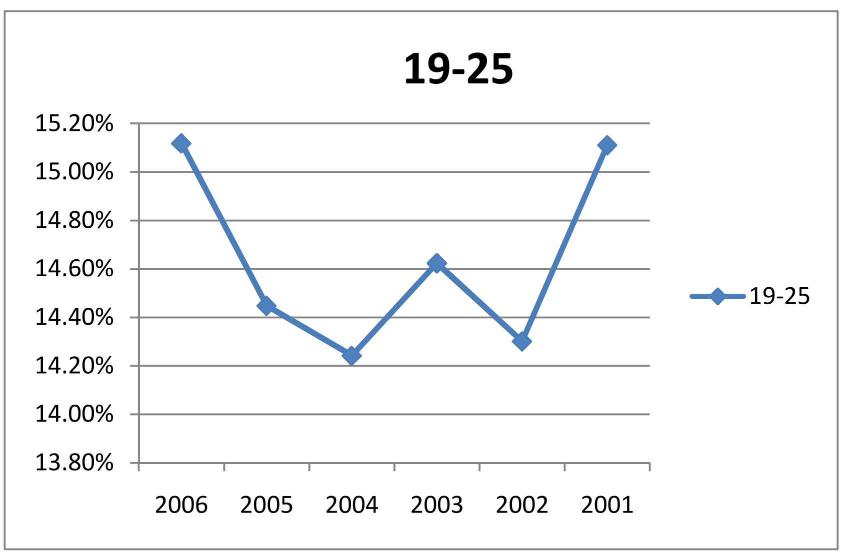


Figure 3: trending accident rate for the 19-25 age group

Since the total number of the accidents for a certain year is the sum of the percentiles in each bracket, data without a noticeable trend would throw off the total if a projected estimate is only applied to brackets with noticeable trends. Therefore the weighted average is applied uniformly to gather the final data.

Once the accident rates are calculated, the sample population has to be divided into the brackets that have been set. Since the data for the sample population is incomplete and different from the brackets for the accident rate, estimates have to be made to subdivide the groups to fit the brackets created for the first section.

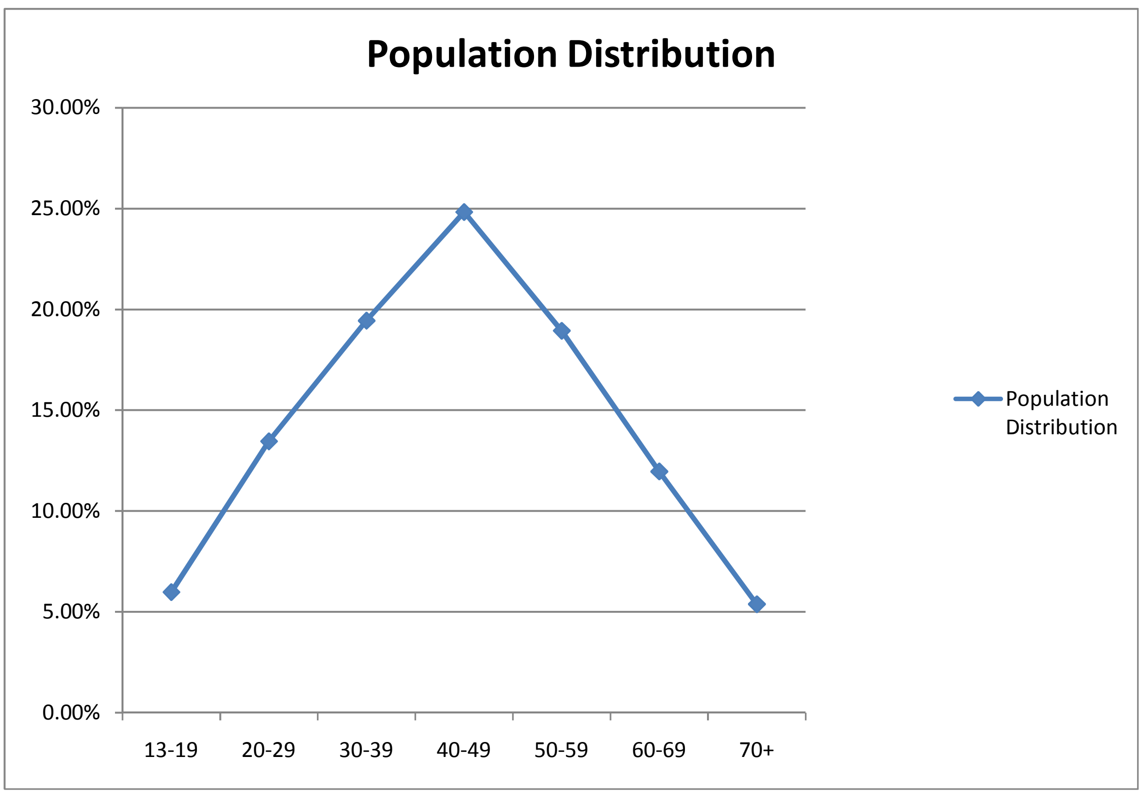


Figure 4: percentage of drivers in each age group

In figure 4, the age groups for driver population is changed into the more general one in figure 1 for accident rate. By utilizing the fact that the graph is nearly linear, the new percentiles are estimated by using the rule of splitting triangles to calculate the area under the line. Since the cutoff bounds for the modified accident rate effectively split some of the current groups in half, the smaller half is estimated to be ¼ of the total in that bracket and the larger half to be ¾. The new spread is graphed in order to make sure it is accurate:

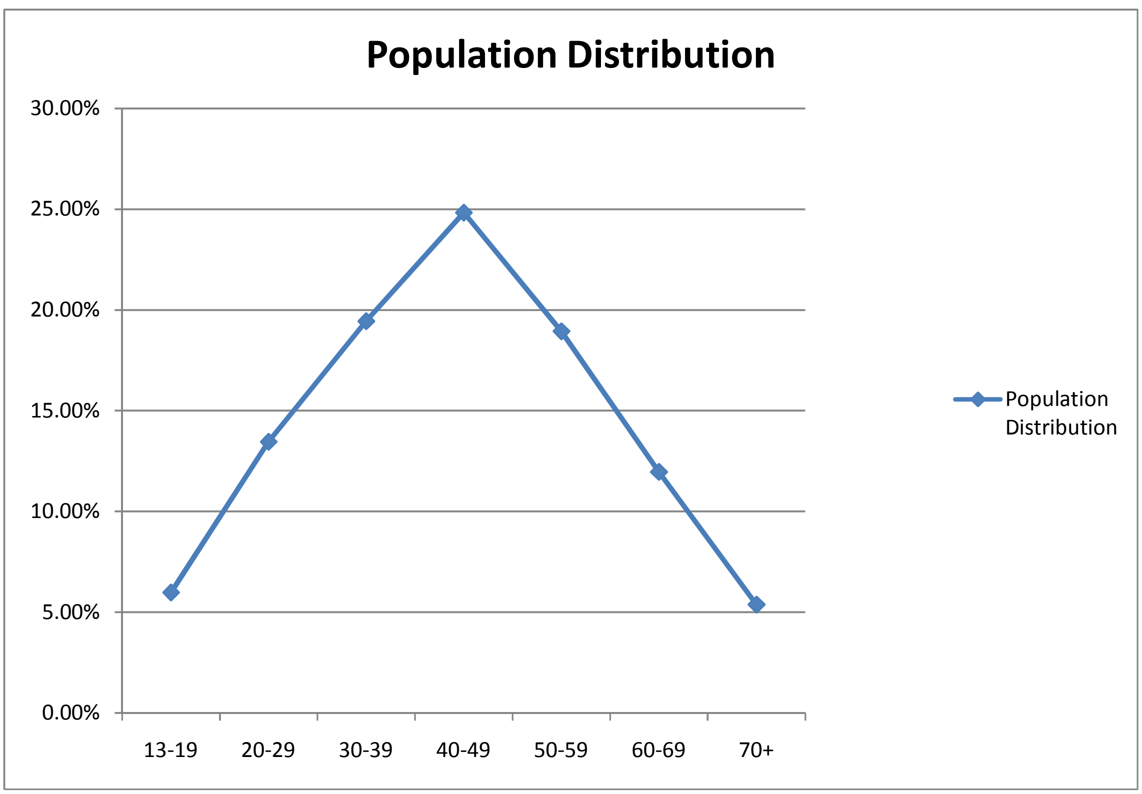


Figure 5: modified percentage of drivers in each age group

Once all the data fit together within each category, the risk probabilities are calculated. However, the main problem arose when tying the three categories together and trying to make sense of the data.

One important factor that has not been introduced yet is the amount of time someone spends on their boat. Due to lack of data this idea was originally not used, but there are some inaccuracies in the data that are illogical, therefore it had to be addressed. Similar to auto insurance, the amount of time or mileage is correlated with the risks of an accident. No matter how safe someone is, given enough time spent on a boat, the odds of an accident will increase. Therefore, the amount of time is introduced as a normalized spread based on assumption, because in the real world, more accurate data would be available for purchase.

The assumptions are based on several logical deductions associated to real life conditions. For the age category, people who tend to be older usually have more resources (money) and time (if you are retiring) to be out boating, therefore the older brackets tend to have a higher average amount of time spent on the water. For the experience bracket, the more hourly experience a driver has can be used to determine how often they spend boating. People with fewer than ten hours of experience are not likely to average hundreds of hours on the water. On the other hand, even though operators with over 500 hours experience might have accumulated those hours from many years of boating, they still tend to spend more time. Therefore, the multipliers for this category are less than those used for the other categories.

For the boating lessons section, it is assumed that people who are willing to put in the time and money to take boating lessons will do so for several reasons. Time spent to prepare for driving classes can be tied to the willingness to spend more time boating. Money spent paying for lessons might also indirectly lead towards this factor. Therefore, the boaters' population is weighed based on the time they tend to spend on the water in order to make the data more realistic. Of course, the more detailed or elaborate lessons are weighed heavier than informal or state courses in terms of operation time. Even without the most accurate data, these assumptions have to be made in order to make the calculations more realistic. All of the numbers used are based on an estimated normal spread to simulate a realistic sample population.

In order to calculate the operator risk coefficient, the three categories have to be tied together. However, it is too inaccurate to just relate them together with just multiplication, because the categories are not independent. Finding the correlation between them is nearly impossible, due to lack of data.

Since the risk rates are based on the average, the majority of the boater population should have approximately the average risk of 100% when combined. The number of boaters in the smaller categories or those with more extreme risk rates will be much less. After trying several methods, finding expected rates, trying to manipulate the data to get a sample variance and trying to simulate pseudo correlations between the three categories, none of the methods worked. Conditional expectations are considered as well but this caused inconsistencies based on which condition is assumed first.

The method that is the most accurate is to take an average of the three. With this approach, the spread created is clustered near the average and the extremes aren't wildly disproportional. The hypothesis on this simple result is that since the data is so correlated, the probability of related conditions occurring is almost close enough to just be an average of the three. After some experimentation, it is decided that the results are accurate enough to avoid further tampering by using weights. The new data is fit onto a different scale with limits on both sides; a minimum of 100% of the average rate, and the maximum is at 220%. These rates are set so that no operator will start at below the average risk, and assure the company does not lose too much money to first year applicants.

The last modifier used is the driver's personal history. Although all data is lacking in this category, the final decision is to model it after how car insurance works. This is necessary because no matter how much data is collected on the standard person and weighed down with sheer numbers and probability, the tendencies of the individual are the most important factor. If someone is accident prone, he might have the safest looking statistic, yet still cause the most damage. Therefore a set of rules are created to calculate how an operator's driving history will affect their risk. This system will assign each person a point based on their performance. A lower point value will reduce your risk while a higher value will increase it.

The guidelines for the point system are as follows:

- A citation received will raise an operator's point value by one
- An accident will result in a penalty of two points.
- Each year a customer remains accident free will result in a deduction of half a point. As the appendix will show, base point value begins at six, which results in no change.
- Each subsequent point will result in a 5% increase or decrease in the risk rate.

- Once the base value of one is reached, each consecutive year without an accident will lower your payment by 2%

Pricing the exact formula for the operator risk rate combines the three driver characteristics with the point system. For drivers with no personal history, an initial value is determined by the three driver characteristics. For drivers with past performance data, a base 100% is used for the average and then deductions/additions will be made based on the point system.

*Scaled Risk: {[(Category risk %)-35%] * 1.25}/ (1.93) + 100%*

Category risk: {[(Experience %) + (Age %) + (Lessons %)] / 3}

The category risk is the combination of the three driver characteristics. Once that is obtained, the formula for the scaled risk is used to convert the risk towards the scale of 100%-220%. 35% is the lowest risk obtainable from the Category risk, and the 1.93 is the difference between the highest and lowest Category risks.

*Initial Risk: (Scaled Risk) * (1 + point value rate %)*

The initial point value is 9 which results in a factor of 15%. This is reduced to 6 if the operator has taken official lessons. After the initial year, the scaled risk gradually deteriorates over 5 years if the customer remains accident free. However, an accident will result in a pause in that deterioration for 4 years.

Deterioration: [(Scaled risk) – 100%] / 5

Updated Scaled Risk: Max [(Scaled Risk) – (Deterioration),100%]

Every year, the updated scaled risk is calculated and multiplied by the point value to achieve the driver's operator risk. If an operator's point value goes to 1, then every consecutive accident free year will see a 2% decrease in their payment. If the point value exceeds 20, the customer will be removed from the insurance policy. Although this becomes a somewhat complicated process to implement due to the large number of customers, with more resources, this process can be automated and the point system coded into macros.

As presented, this approach provides a basis to separate boat operators into distinct risk categories depending on their personal characteristics. Analysts will monitor this process as well as changing parameters from time to time based on accrued data.

Chapter 6: Boat Risk

After the operator risk has been found, the next step is to find the risk applied to each boat type. In order to price the boat insurance, three factors are needed: operator risk, boat risk, and boat value. The different types of boats that GLIC will insure are divided into two categories: motorboats and personal watercrafts. Within each category, there may be minor differences in the features of the boat, but due to having a similar size and method of propulsion, the risk of an accident is roughly equal. To give the reader an idea of where the calculations are headed, the final boat risk values can be summarized as:

*BR = ∑[relative accident rates * severity of the accidents * chance of accident occurring]*

However there are several calculations that need to be completed before the final equation can be used to produce the boat risk value. The first step is to weigh the data from 2006, 2005, and 2004.

[6(2006 data) + 5*(2005 data) + 4*(2004 data)]/15*

This is done to give more weight to the later years since those numbers are more appropriate for the present situation. The following is the weighted data for motorboats:

2006 Total Accidents	2006	2,005	2,004	Weighted Average
Total	4,292	3,415	4,309	4,004
Capsizing	266	200	245	238
Carbon Monoxide Exposure	15	11	11	13
Collision With Fixed Object	431	302	439	390
Collision With Floating Object	138	101	83	111
Collision With Vessel	1,446	1,129	1,588	1,378
Departed Vessel	38	28	43	36
Ejected From Vessel	18	6	33	18
Fall In Boat	155	134	134	142
Fall On Boat	1	0	3	1
Falls Overboard	271	248	294	269
Fire Or Explosion Of Fuel	137	124	159	139
Fire Or Explosion - Other	100	43	58	70
Flooding/Swamping	192	178	233	198
Grounding	219	214	186	209
Other Casualty	86	25	60	59
Sinking	102	75	124	99
Skier Mishap	438	342	353	383
Struck By Boat	37	41	72	48
Struck By Motor/Propeller	107	81	62	86
Struck Submerged Object	80	117	93	96
Unknown	15	16	36	21

Figure 6: weighted average of the number of accidents

When comparing several boat types against each other, it is beneficial to select a common type to compare them to. GLIC has chosen motorboats to represent the standard since they are the most popular type of boat in use. The next step is to find a comparison of the overall chance of getting into an accident and the chance of getting into each type of accident because certain accidents cause more property damage than others. Motorboats are assigned a boat risk value of one. Observe the following data which is being used to calculate the boat risk value for PWCs:

Accident Type	**Propeller**	**Water Jet/PWC**	**% of total propeller**	**percentage of total PWC**	**relative accident rate**
TOTAL	4,004	1,780			
Capsizing	238	31	5.94%	1.74%	29.30%
Carbon Monoxide Exposure	13	1	0.32%	0.06%	17.30%
Collision with Fixed Object	390	100	9.74%	5.62%	57.68%
Collision with Floating Object	111	37	2.77%	2.08%	74.98%
Collision: Vessel	1,378	1,146	34.42%	64.38%	187.07%
Departed Vessel	36	1	0.90%	0.06%	6.25%
Ejected from Vessel	18	15	0.45%	0.84%	187.45%
Fall In Boat	42	45	1.05%	2.53%	241.01%
Fall On Boat	1	42	0.02%	2.36%	9447.64%
Falls Overboard	269	150	6.72%	8.43%	125.43%
Fire/Explosion –Fuel	139	18	3.47%	1.01%	29.13%
Fire/Explosion – Other	70	3	1.75%	0.17%	9.64%
Flooding/Swamping	198	16	4.95%	0.90%	18.18%
Grounding	209	26	5.22%	1.46%	27.98%
Other Casualty	59	14	1.47%	0.79%	53.38%
Sinking	99	8	2.47%	0.45%	18.18%
Skier Mishap	383	50	9.57%	2.81%	29.37%
Struck by Boat	48	55	1.20%	3.09%	257.75%
Struck by Motor/Propeller	86	4	2.15%	0.22%	10.46%
Struck Submerged Object	96	13	2.40%	0.73%	30.46%
Unknown	21	8	0.52%	0.45%	85.69%
Registration	7,724,530	3,128,965			
Accident Rate	0.0518%	0.0521%			
Adjusted Rate	1.0367%	1.0426%			

Figure 7: Relative ratio of accidents by accident type and calculations for adjusted accident rates

From the results in columns 2 and 3, it can be seen that the overall chance of getting into an accident with a PWC is roughly the same as with a motorboat. However, the same cannot be said when discussing each type of accident. A risk comparison for each type of accident needs to be found. In order to do this, the assumption that the accident has occurred with a certain type of boat has to be made. The first ratio that needs to be found is:

$$\frac{P(\text{accident type A for PWC} \mid \text{accident for PWC has occurred})}{P(\text{accident type A for motorboat} \mid \text{accident for motorboat has occurred})}.$$

These are found in columns 4 and 5. Dividing the first probability by the second leads to column F, this is the risk factor for each type of accident. This percentage is how much more likely a specific type of accident it to occur for a PWC compared to a motorboat. This is useful because certain accidents are more costly than others.

The next step is to calculate the expected losses for each type of accident. This will be done by assigning a severity factor to each type of accident. Accidents that cause more damage will generally be more severe. The most common type of accident, which is collision with another vessel, was assigned a significance factor one. The average cost of this accident was $6,669. All ratios were found by comparing the cost of the accident to this cost. After analyzing the property damage for all the accidents over the past 3 years, we are able to assign significance factors to each type of accident. The following data includes accidents for both motorboats and PWCs:

2004-2006 Total	Accidents	Property Damage	Prob./Year	Avg. Damage	Severity Factor
Total	4947	$39,143,273	0.0390%	$7913	1.20
Capsizing	430	2,316,268	0.0036%	5386	0.81
Carbon Monoxide Exposure	15	33,167	0.0001%	2261	0.34
Collision W/ Fixed Object	513	4,626,426	0.0041%	9018	1.36
Collision W/ Floating Object	122	1,004,667	0.0011%	8257	1.25
Collision W/ Vessel	1406	9,374,610	0.0107%	6669	1.01
Departed Vessel	15	28	0.0000%	1	0.00
Ejected From Vessel	34	261,024	0.0003%	7753	1.17
Fall In Boat	141	68,440	0.0016%	486	0.00
Fall On Boat	96	48,231	0.0002%	500	0.00
Falls Overboard	490	380,005	0.0038%	774	0.00
Fire Or Explosion - Fuel	148	7,377,366	0.0011%	49847	2.50
Fire Or Explosion - Other	59	5,090,574	0.0005%	86771	2.50
Flooding/Swamping	232	2,004,350	0.0017%	8627	1.30
Grounding	253	2,688,285	0.0020%	10639	1.61
Other Casualty	70	138,914	0.0008%	1984	0.00
Sinking	123	2,221,889	0.0009%	18015	2.72
Skier Mishap	451	11,134	0.0040%	24	0.00
Struck By Boat	81	81,582	0.0005%	1011	0.00
Struck By Motor/Propeller	90	11,063	0.0008%	122	0.00
Struck Submerged Object	110	1,045,487	0.0007%	9533	1.44
Unknown	35	355,293	0.0002%	10055	0.00

Figure 8: estimating the cost of each accident

Trivial accidents that incur small amounts of damage are given a severity factor of 0, since the deductible will often cover the costs for the accident; these are likely to not get reported. Sinking, or fuel explosions are more costly then collisions because these accidents usually require a total replacement of the boat where as collision with another vessel averages out to costs 40% of the boat value. It is important to note that 40% does not mean each collision does about 40% boat value damage. It means there is a high variation in damages, which happens to average out at 40%. Since we are comparing everything to collision with another vessel, the highest Severity factor is 2.5 because losses greater than 100% of the boat value (40% * 2.5 = 100%) cannot occur. Several of the calculations in the final columns were adjusted to the maximum and minimum severity factors to apply to real life situations as explained above.

The goal is to create a boat risk value where, if greater than 1, that specific type of boat is expected to incur more losses relative to its boat value because it is likely to get into accidents that incur more damages. The opposite is true for boat risk values less than 1. Thus far, the relative chances of getting into a specific type of accident and how costly that accident is going to be has been calculated. Multiply the two numbers together to weigh the severity factors by their relative chances of occurring. These will be called the weighed severity factors.

The next step is to multiply the weighted severity factors by the chances of an accident occurring. An important point needs to be clarified because it may seem like we are multiplying the chance of a specific accident occurring twice, but this is not the case. The first is the relative risk of each accident type. For example, this is the chance of a specific accident occurring for a PWC compared the chance of an accident occurring for a motorboat. This does not tell us how often the accident occurs in general. Among the first few columns you will notice the column headers “percentage of total PWC”. These numbers are:

P(accident type A for boat type A |accident for boat type A has occurred).

For each accident type, relative accident rates are compared; the impact of the accident, and the overall chance of the accident occurring. Since the relative accident rate for each boat type is being compared to motorboats, the sum of these percentages, if the calculations were done for motorboats, would be equal to 100%. If the sum is greater than 100%, the boat risk for the specific type of boat is higher meaning it is more likely to get into accidents that will incur losses equal to a higher percentage of it boat value. The following is the data for PWCs:

Severity Factor	Weighted Severity %	Final Severity %
0.81	23.84%	0.42%
0.34	5.91%	0.00%
1.36	78.58%	4.41%
1.25	93.54%	1.94%
1.01	188.49%	121.35%
0.00	0.00%	0.00%
1.17	219.57%	1.85%
0.00	0.00%	0.00%
0.00	0.00%	0.00%
0.00	0.00%	0.00%
2.50	72.82%	0.74%
2.50	24.10%	0.04%
1.30	23.69%	0.21%
1.61	44.98%	0.66%
0.00	0.00%	0.00%
2.50	45.44%	0.20%
0.00	0.00%	0.00%
0.00	0.00%	0.00%
0.00	0.00%	0.00%
1.44	43.87%	0.32%
0.00	0.00%	0.00%
	Total:	132.15%

Figure 9: Calculated Final BR Value

PWCs have a boat risk value of 1.3215. The calculations for sailboats have also been made but they are not insured by GLIC. Sailboats have a boat risk value of 1.377 and the calculations for this value can be found in the appendix. The boat risk value of any boat type can be found using this method. This does not imply that both these boat types are expected to incur more losses per boat than motorboats. It means they are expected to incur a higher loss relative to their total boat value. In general, motorboats are more expensive and thus have a higher overall loss rate per accident.

Once again, the final equation can be summarized as:

*Relative boat risk value = ∑ [relative accident rates * severity of the accidents * chance of accident occurring]*

Chapter 7: Estimating yearly losses

Both operator risk and boat risk have been calculated and will be used in the equations for expected losses. All the losses will be calculated on a per year basis because the final product will be priced given a yearly quote. All the equations follow a similar, logical format. This format is a rate, or chance, that an accident will occur within a given year, multiplied by the expected cost of an accident. The cost of the accident includes the subtraction of the deductible which is always $1,000 for GLIC. Finally, expenses for each policy need to be added.

Personal Property

The personal property coverage option covers all property damage on the insured's boat in the event of an accident. This coverage generally includes all accidents regardless of who is at fault. It does not, however, included accidents performed intentionally for the purpose of receiving an insurance claim, which is considered insurance fraud.

To calculate expected losses for personal property, the same equation format will be followed as previously mentioned. For the rate, all factors that affect accident rate must be taken into consideration. Remember, boat risk does not affect the rate of an accident, only the expected cost of an accident. Operator risk will be included in the accident rate. To reiterate, operator risk can have a range of values assigned to it but the mean value is one. First, a base accident rate must be calculated. The following table shows the accidents per year for motorboats and their weighted average over three years:

Year	**2006**	**2,005**	**2,004**	**Weighted Average**
Accidents	4,292	3,415	4,309	4,004

Figure 10: Accident rates & weighted average

For this project, all data is taken as a weighted average over the past three to six years depending on availability. In this case, it is only accurate three years back using USCG statistics. The average number of registered boaters during this time period is 7,724,530. Simply dividing the number of accidents by the number of registered accidents gives a base accident rate. However, GLIC operates under the assumption that only 5% of all accidents are reported to USCG statistics. Thus, our rate is multiplied by 20 to represent 20 times as many accidents. This gives an accident rate, C, equal to 1.0366%. The accident rate can be expressed as C*OR.

An expected cost of each accident must be calculated. This is dependent on boat risk. Motorboats have an average loss equal to 40% of their boat value. This is modified by the BR risk value for PWCs. The projected property damage on a PWC is about 53% of the boat value. A BR of 1.3215 is used to modify the 40%. It also must be noted that the deductible is to be subtracted from the damage of each accident because this is the amount that the Insured is paying out of his or her pockets. Our expected cost is simply (.4*BR*BV-D) where BR = boat risk, BV = boat value and D=deductible.

The company's total expenses are split between all coverage options according to how many policies are purchased. An amount, E, is added to each coverage option. All these factors together produce an equation for the expected losses per customer on a yearly basis for personal property coverage:

$$L = (C*OR)(.4*BR*BV-D) + E$$

Liability

Liability covers the insured for damages and medical costs inflicted upon another. Liability is the most popular coverage option among the boat and auto insurance industry because it covers unexpected costs. Many people choose not to purchase personal property damage coverage because these losses can be anticipated. People often know whether or not they can afford to lose their automobile or their boat if an unfortunate accident may occur. What no one can predict is the severity of losses that can come when you are the one at fault for inflicting damage upon another person or their property. This person may also choose to sue you for other reasons as well such as “emotional distress”. In instances like this, legal costs are also unknown.

The equation for expected losses for liability will look similar to that of the equation for expected losses for personal property damage. The difference being that the medical and property damage inflicted upon another cannot be predicted as easily. This is for two reasons; the first being that the value of the boat that will be hit is unknown. The second is the severity of injuries that could be inflicted upon others during an accident is unknown. USCG lacks information on the cost of injuries that can occur at sea.

It was decided that estimates must be approximated using insurance quotes. Fortunately, this proved to be easy as the quotes were consistent. Using operator inputs that would produce an OR (operator risk) equal to about one (new driver, had boat lessons, experienced, no violations) and using a deductible of $1,000; it was found that a consistent liability cost was given for each boat type. Boat value has no impact on liability costs; this is expected because you are paying for an unknown boat value that belongs to another. This cost can only be approximated as an average over all boats. The same must be done for medical payments. The cost of PWCs for liability coverage was consistently $100. Motorboats tend to vary because companies with more resources differentiate between engine types. This base cost was typically about $125. Here is a copy of the one of the quotes received for Liability coverage on a PWC:

****
****
Thank you for completing a quote with us. When you're ready, you can buy your policy online
at https://www.progressive.com/retrieve.asp?product=BT
or call 1-888-438-1263 to start your coverage immediately.

YOUR 12 MONTH RATE:

***** Paid in Full Payment Option *****
Payment Amount: $100.00

Note: Payments may include an installment charge that can vary by payment method. With most payment options, you can reduce your installment charge by using our Electronic Funds Transfer feature, which deducts installment payments directly from your checking account.

****
****

Coverage Information

Watercraft #1 -2006 Lavey Craft 21 XCS

Bodily Injury & Property Damage:

$100,000 person/$100,000 property damage

Watercraft #1

Comprehensive:

No coverage

Collision:

No coverage

Figure 11: Sample Quote from Progressive

Watercraft #1 is a 2006 Lavey Craft 21 XCS. This type of boat is a PWC. The first coverage option is for liability. $100,000 person refers to medical payments including legal fees if you are sued. All liability coverage options will include a ceiling of $100,000 for medical payments and $100,000 for property damage. This is the standard for GLIC.

Many quotes were received similar to the format above. GLIC differentiates between all types of boat as much as possible. PWCs proved to be consistent at $100 while motorboats ranged from about $120 to $130. A mean of $125 is used for motorboats. Options such as adding violations or not having had boating lessons increases the price. This can be represented by the operator risk value. After seeing the consistency of the quotes given from Progressive and US Marine, it was clear that these insurance companies simply projected the average liability cost of an accident. This value is used for all policies because liability damage is independent of the value of your own boat. The final equation should look like this:

$L_C = (C*OR)(AL - D) + E$

Where AL = average liability losses

Every variable or constant above is known except AL. Insurance companies will not simply charge their expected losses; they want to earn a 10-15% on the policy. This will be reposted several ways to assure that the company will indeed make a profit in a later section. The most accurate way to earn an average of 15% on each policy is to simply multiply the expected losses by 1.15. Knowing this, we can work backwards to solve for AL.

- AL_{pwc} = [(L – E)/(C*OR) + D]
  With L = $100/1.15, E = $42.00 (expected expenses per coverage option)
- C = .010366, OR = 1
- D = 1000
- P = profits = 1.15 for 15% profit

In this case AL_{pwc} = $5336.92. The same calculation can be done for motorboats:

- AL_{pwc} = [(L – E)/(C*OR) + D]P
  With L = $100/1.15, E = $42
- C = .010366, OR = 1, D = 1000, P = 1.15
- AL_{mb} = $7434.08

All the constants for the final equation to estimate the yearly liability loss per policy are now known. Once again, the final equation is:

*L = (C*OR)(AL – D) + E where AL = average liability losses*

Chapter 8: Medical Payments

Medical payments are a minor type of boat insurance coverage. The upper limit that a customer has chosen determines the price. In order to find the expected value, one needs to first find the probability of injuries occurring. According to the data we have, the average chances of injuries over the past three years are shown in the following table:

	Registered Boats	Total Injuries	Average Chances
2004	12,781,476	3,363	0.0263%
2005	12,942,414	3,451	0.0267%
2006	12,746,126	3,474	0.0273%

Figure 12: Chance of injury

It is assumed that all the reported accidents and injuries are 20 times greater than what is reported, so the adjusted probabilities of injuries are 20 times larger than the table above. For example, in the year 2004:

*Adjusted chance = 0.000263115*20 = 0.007893455*

The upper limits of medical payments are classified into five levels: $1000, $2000, $5000, $7500, $10000 respectively. Assuming that every claim of injuries reaches its highest limit, the average medical payment would range from $7.89 to $81.77 per customer for

2004 data. The initial expected costs of medical payments per customer are:

Injury Costs	2004	2005	2006
1000	7.89	8.00	8.18
2000	15.79	16.00	16.35
5000	39.47	40.00	40.88
7500	59.20	60.00	61.32
10,000	78.93	80.00	81.77

Figure 13: project losses for medical payments

Not every loss reaches the upper limit, thus the costs do not have a linear relationship based on upper limit values as assumed in the table above. The following chart assumes a linear relationship between each level using the standard method for weighting data over the past three years:

Injury Costs	2004	2005	2006	Average
1000	7.89	8.00	8.18	8.04
2000	15.79	16.00	16.35	16.08
5000	23.68	24.00	24.53	24.13
7500	31.57	32.00	32.71	32.17
10,000	39.47	40.00	40.88	40.21

Figure 14: weighted average of projected costs for each medical limit

The next step is to compare the results thus far with real boat insurance quotes, which can be gathered from existing companies such as Progressive and Boat U.S.

The Standard inputs are set as:

- # of boats: 1
- # of operators: 1
- I currently do NOT have a policy with Progressive
- Model Year: 2005
- Make: Yamaha AR 210
- No co-owner
- Boat value: $17,000
- HP: 135

Progressive offers many choices for upper limits on different types of coverages. Adjusting only medical payments and boat values, the selected quote prices from Progressive are:

Medical limits	**Quote price (BV $17,000)**	**Quote price (BV $20,000)**
1000	529	556
2000	538	565
5000	548	575
7500	557	584
10000	567	594
0	519	546

Figure 15: Full policy prices from a sample quote

These quotes are for a policy that includes all coverage options. This is done to reduce the expenses tacked onto a single coverage option. In addition, some companies do not allow the purchaser to simply purchase medical coverage without purchasing liability as well. There is approximately a "$10 increment" between upper limits. This is consistent with the chart assuming a linear relationship between upper limit levels. It is important to be clear on where the linear relationship exists. A customer who chooses a $10,000 limit doesn't mean that his medical bill will cost five times more than the customer who chooses $2,000; it may even cost less. The linear relationship exists between the five levels of upper limits. The five medical limit values will be assigned values (1-5)

The equation for expected losses on a yearly basis is:

- $L_{mp} = (IR*AM*ML) + E$
  - IR = injury rate
  - AM = average medical cost
  - ML = medical limit level

The projected accident costs calculated in this section does not include expenses, only the section within the parenthesis. Once again, these are:

Upper Limits	**Expected Medical Costs Per Year**
1000	8.04
2000	16.08
5000	24.13
7500	32.17
10,000	40.21

Figure 16: Expected medical losses

Chapter 9: Death Benefits

Death benefits, similar to medical payments, are a low cost coverage option available to those purchasing boat insurance. It pays an amount X, to the family of the deceased upon a boating accident resulting in the death of the insured. The Great Lakes Insurance Company will be presenting $50,000 as the compensation to the family of the deceased.

The payment that the insured owes on a yearly basis should have little variation in costs and thus, are easy to calculate with the given statistics. According to the data, there are only two factors that have a significant impact on the risk of a fatality. These factors include whether the purchaser has had boating lessons and if the boat is used in winter. Quick calculations from the data set show that the risks of using a boat during the winter months increased the chance of a fatality by 1.76 times. This number is calculated using the data below by simply taking the fatality rate for the six winter months (October-March) and dividing it by the fatality rate for the six summer months (April-September).

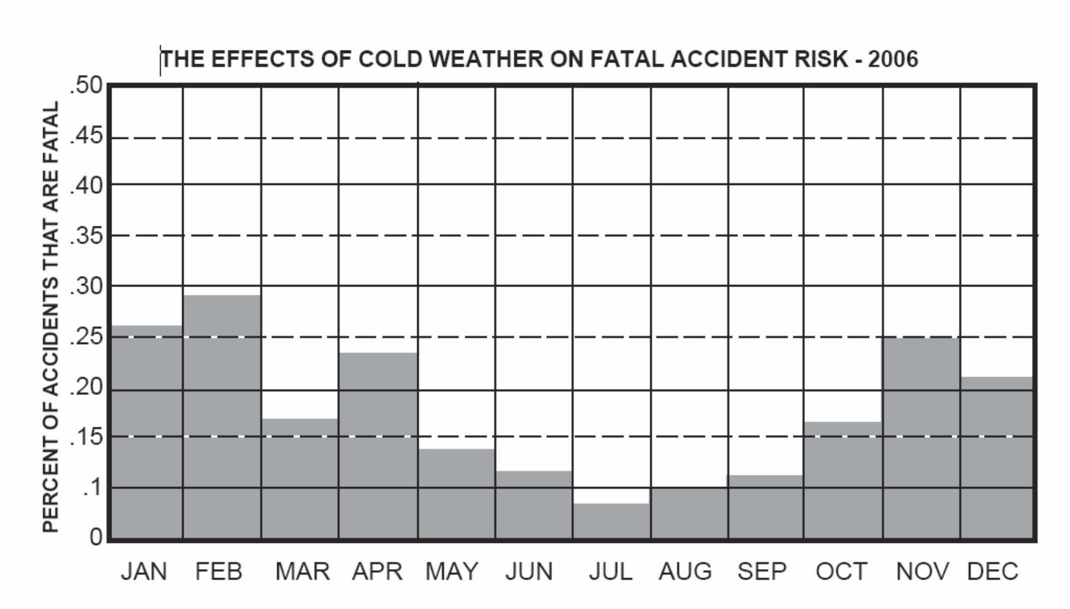


Figure 17: Weather statistics

BOATERS ARE MORE LIKELY TO PERISH IF THEY ARE INVOLVED IN A REPORTED ACCIDENT DURING THE FALL & WINTER MONTHS

MONTH	FATAL ACCIDENTS	NON-FATAL ACCIDENTS	TOTAL ACCIDENTS	FATAL ACCIDENT RISK	TOTAL FATALITIES
January	22	63	85	26%	24
February	27	66	93	29%	33
March	26	119	145	18%	33
April	65	211	276	24%	75
May	81	518	599	14%	93
June	96	719	815	12%	106
July	116	1,253	1,369	8%	126
August	79	705	784	10%	85
September	49	388	437	11%	54
October	32	160	192	17%	37
November	25	75	100	25%	28
December	15	57	72	21%	16
Total	633	4,334	4,967		710

Figure 18: Monthly fatality statistics

Using the data from chapter 5, the operator risk section, the additional risks of not taking boating lessons can be calculated. Approximately 61% of the population has never taken boating lessons. This can be combined with the information below:

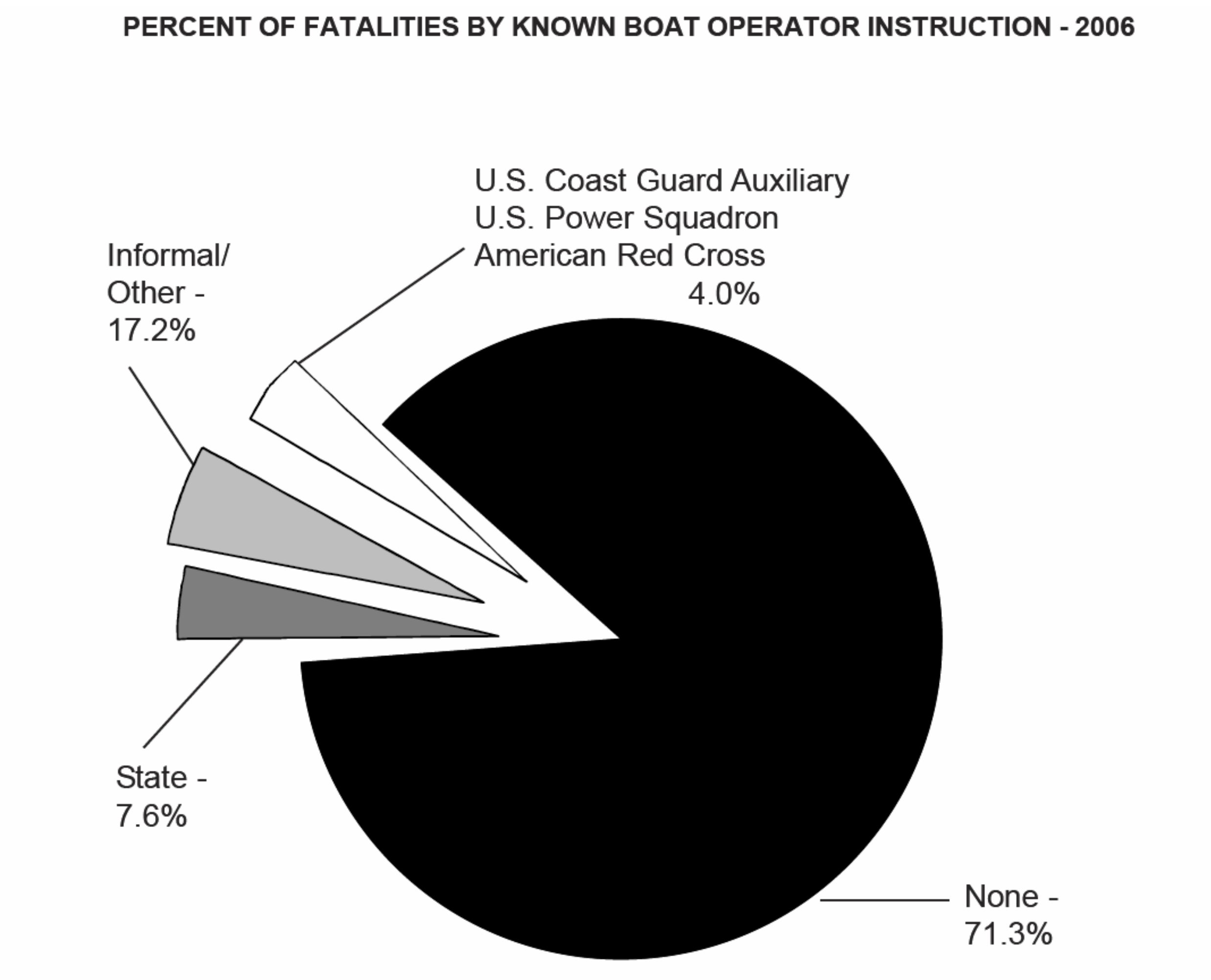


Figure 19: Fatality break down by lesson type

Assuming a fatality has occurred, there is a 71.3% chance that the operator has not taken boating lessons.

The equation to solve is:

P(fatality ∩ no instruction)/P(fatality ∩ instruction).

Utilizing the basic laws of probability, the numerator is equal to:

*P(no instruction |fatality) * P(fatality).*

The denominator is equal to:

*(Instruction |fatality) * P(fatality).*

This simplifies down to:

P(no instruction |fatality)/(instruction |fatality)

If one has never taken boating lessons, the chances of a fatality increases by .713/.287 = 2.48 times. This is equivalent to the maximum possible value for operator risk. Although all risk factors from the operator risk section will affect the fatality rate, USCG only shows fatality rates using boating lessons. Since the range of values is so consistent, operator risk can be used as a replacement.

The next step is to calculate the risk equations' constant fatality rate, FR, must be found. This will be the chance of a fatality occurring within a year assuming it is not used in the winter and the purchaser has had boating lessons (The equivalent in the final equation will be OR = 1). In order to find K, The entire equation is set to equal:

5.5×10^{-5}

This number is the proportion of fatalities in general relative to the total number of registered boaters. USCG is accurate with the number of fatalities since al fatalities are reported, thus the 5% accident assumption does not need to be applied to the fatality rate. Since this value is the average fatality rate over all factors, it is used to help find the FR, fatality rate, under the specific safe conditions. In the end, this value needs to then be multiplied by both risk factors.

The next step is to use the data to estimate how many customers would use their boat in the winter and would not have taken lessons, use their boat in the winter and have taken lessons, not use their boat in the winter and not have taken lessons, or fall under the specific safe conditions. Multiply these percentages by their respective risk factors to help find the FR. Using the data, it is estimated that 22.8% of customers will have taken boating lessons and not be using their boat in the winter. 15.4% of customers will be using their boat in the winter, but have taken lessons. 45% of customers will not be using their boat in the winter but have not taken lessons. And 16.8% of customers will have not taken lessons and be using their boat in the winter. If the latter is the case, the multiplier is:

$$2.1 * 2.3 = 4.83$$

Calculating for FR, one gets:

$[(22.5*1 + 15.4*2.1 + 45*2.3 + 16.8*4.83)/100]*K = 5.5 \times 10^{-5}$, thus $FR = 6.51 \times 10^{-7}$.

Recall that GLIC is paying $50,000 for the death benefit. Now that FR has been calculated and all the risk factors are known, the resulting risk equation for death benefits is simply:

$$L = FR*W*OR*50,000 + E$$

W = 1.76 if used in winter, 1 if not OR = operator risk

Notice the similarity between this equation and the others. It is simply an accident rate adjusted by factors, multiplied by the expected cost of an accident with expenses tacked on. In this case, the expected costs per accident are almost 100% accurate because the company always pays out exactly $50,000.

Chapter 10: Profits

The goal of any company is to make a yearly profit. For the Great Lakes Insurance Company, the goal is to receive a yearly profit of 10%-15% with a good margin of safety. In order to accomplish this, the risks and expected loss have to be scaled. If the average loss is used, there will be a high variation among yearly claims paid, depending on luck. While having a bigger customer pool helps prevent this problem, this is not sufficient to insure a profit for the company.

For an average contract, the total expected loss for each category is calculated and summed. This in turn becomes the total loss per given contract. Since this factor becomes the only risk factor, the others being expenses, a margin of safety is applied. A normal distribution would be the ideal in this case. However, due to the nature of our data, the variance is almost impossible to find. Therefore, the average expected loss is applied to a Chi-Squared distribution under which the variance is twice the mean.

Chi-Squared PDF: $$\frac{(1/2)^{k/2}}{\Gamma(k/2)} x^{\frac{k}{2}-1} \varepsilon^{\frac{-x}{2}}$$

With K equal to the mean expected loss, the data is graphed to present a visual representation of the losses. With the Chi-Squared distribution, the PDF begins at zero unlike the Normal, so there is no need to factor out the negative piece.

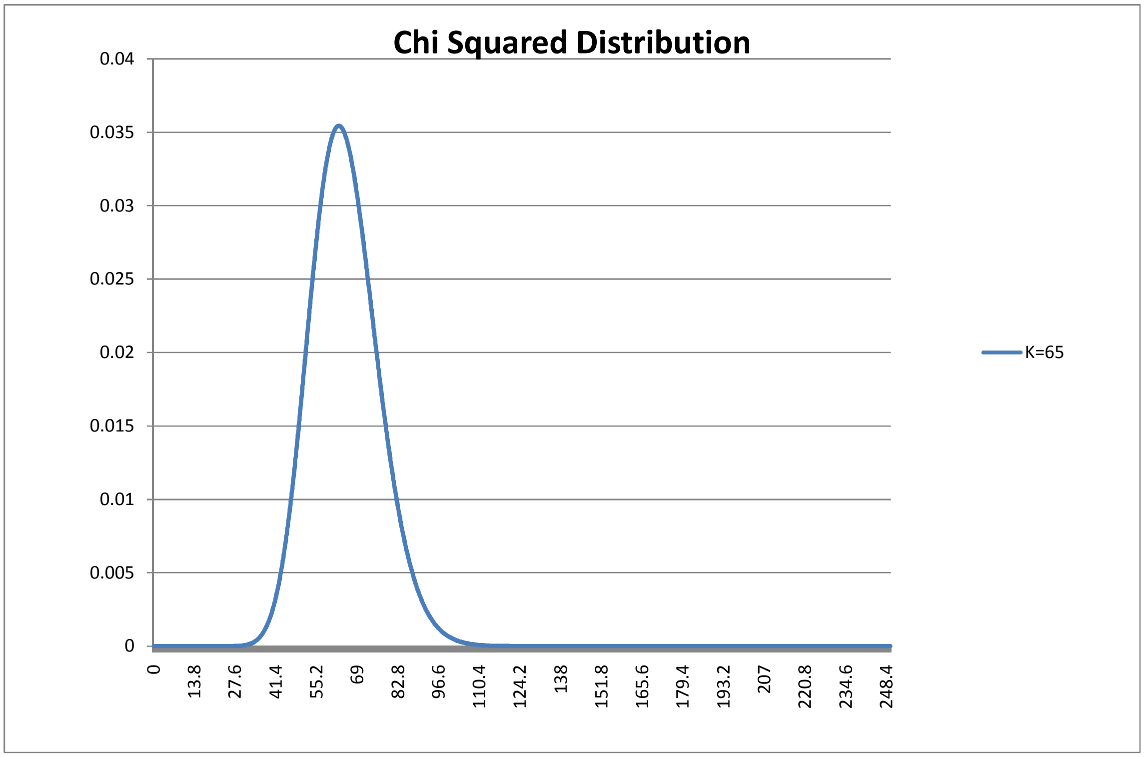


Figure 20: Chi Squared graph of the expected losses

Once the results are graphed, the 99% mark is calculated by taking the area under the curve. This amount is the final expected loss amount that will maintain 99% of the contracts will not have expected losses higher than the projection. Once the expenses are added, a markup of 15% is applied to achieve the targeted profit range.

Chapter 11: Conclusion

For the purpose of this project, The Great Lakes Insurance Company has created a unique boat insurance product, marketed in six of the states that make up the Great Lakes region. In order to accomplish its original goals, GLIC has concentrated all of its attention to a relatively small area of the United States. By opting for boat insurance as opposed to health or life, the company can join a fairly small group of companies and compete competitively for a larger market share. With the limited data that was available to the company, breakdown of the risks, expenses, and accident rates are carried out in order to simulate a pricing process similar to real world companies. The finished product consists of 4 different coverage options. The first three are standard plans:

- Personal Property Damage
- Liability Coverage
- Medical Coverage

The fourth offered product is unique to GLIC, Death Benefits, which pays a sum of money in the event of death.

Within each coverage option, risks exist that can alter accidents rates and the severity of accidents. These risks are represented by operator risk and boat risk. Data from the USCG yearly census is used to calculate the values for each risk category given specific inputs that were deemed significant. With more resources available, additional risk factors could play a part within each category; however, they would have minor roles.

Expected losses are calculated on a per year basis using a standard equation format of the accident rate multiplied by the projected costs of each accident. Finally, yearly expenses are added on. The goal of the project was to assure at least a 10-15% profit. A chi-squared distribution is used to adjust the losses so we can be 99% confident that they will not exceed what is being charged. The adjust losses are multiplied by 1.15 to earn a profit of 15%.

Work Cited:

1. United States Coastal Guard and United States Department of Homeland Security. *U.S. Coast Guard Accident Statistics*. http://www.uscgboating.org/statistics/accident_stats.htm

2. Progressive. *Boat Insurance Made Easy*. http://www.progressive.com/insurance/boat/quote-in-minutes.aspx

3. BoatU.S. Marine Insurance, "*Boat Insurance Quick Quote Request"* https://www.boatus-insurance.com/insappNew/Default.asp

Appendix:

Census Of The 25 States With The Most Registered Boats 2001-2005:

Years	2005	2004	2003	2002	2001	2000
Florida	973,859	946,072	939,968	922,597	902,964	840,684
California	963,758	894,884	963,379	896,090	957,463	904,863
Michigan	944,138	944,800	953,554	1,000,337	1,003,947	1,000,049
Minnesota	853,489	853,448	845,379	834,974	826,048	812,247
Wisconsin	639,198	605,467	610,800	619,124	575,920	573,920
Texas	614,616	616,779	619,088	624,390	621,244	626,761
New York	508,536	519,066	528,094	529,732	526,190	525,436
South Carolina	416,763	397,458	380,314	383,971	382,072	383,734
Ohio	412,375	414,938	413,048	413,276	414,658	416,798
Illinois	380,865	393,856	360,252	398,431	369,626	372,162
North Carolina	362,784	356,946	359,857	353,625	353,560	349,631
Pennsylvania	349,159	354,079	355,235	357,729	359,525	359,360
Missouri	326,749	326,210	326,153	325,717	335,521	334,460
Georgia	318,212	322,252	326,718	325,135	327,026	322,681
Louisiana	308,104	309,950	307,051	327,272	322,779	314,321
Washington	267,793	266,056	265,773	266,717	260,335	257,625
Tennessee	267,567	261,465	261,636	259,235	256,670	269,583
Alabama	265,172	264,006	262,249	264,191	262,016	265,458
Virginia	245,073	242,642	241,993	243,590	240,509	237,228
Iowa	243,924	228,140	210,836	229,705	210,841	223,573
Oklahoma	216,913	206,049	229,778	228,064	229,454	230,524
Indiana	214,696	213,309	216,145	218,363	218,255	219,189
Mississippi	208,466	209,216	201,457	199,037	300,970	292,335
Maryland	205,812	206,681	198,395	198,012	197,005	208,186
Arkansas	205,414	205,745	196,215	199,293	199,713	177,912
Total	12,942,414	12,781,476	12,794,616	12,854,054	12,876,346	12,782,143

Accident Rates For The 25 States With The Most Registered Boats 2001-2005:

Years	2005	2004	2003	2002	2001
Florida	603	713	752	831	993
California	630	603	797	745	771
Michigan	161	143	218	226	299
Minnesota	114	88	106	122	125
Wisconsin	127	107	126	148	164
Texas	144	159	198	204	206
New York	190	178	224	212	223
South Carolina	83	83	108	105	123
Ohio	132	105	122	140	139
Illinois	101	72	82	134	108
North Carolina	164	140	144	138	179
Pennsylvania	61	58	79	74	80
Missouri	202	172	201	192	226
Georgia	111	118	141	131	113
Louisiana	126	156	130	145	154
Washington	128	134	126	111	117
Tennessee	114	173	155	129	132
Alabama	69	70	83	70	87
Virginia	127	136	115	121	152
Iowa	53	32	25	38	36
Oklahoma	62	55	72	72	86
Indiana	41	51	56	97	120
Mississippi	23	35	41	43	64
Maryland	183	178	146	161	186
Arkansas	68	55	50	74	75
Total	4,969	4,904	5,438	5,705	6,419

Total Dollars Lost in Each State from 2001-2005:

Years	2005	2004	2003	2002	2001
Florida	$5,350,629	$10,069,934	$9,743,437	$8,221,119	$7,413,780
California	3,381,151	4,005,301	3,672,500	3,312,300	2,741,850
Michigan	338,127	1,014,434	723,083	601,747	1,572,466
Minnesota	351,577	297,691	622,501	339,349	561,289
Wisconsin	439,230	320,284	364,527	530,101	1,139,064
Texas	702,669	901,673	614,471	942,116	809,796
New York	1,321,878	1,284,219	2,330,731	971,995	1,086,412
South Carolina	144,537	768,404	438,111	296,305	512,851
Ohio	959,262	391,093	698,521	392,972	673,905
Illinois	253,845	243,950	266,616	414,079	308,014
North Carolina	870,085	486,805	682,422	943,382	727,946
Pennsylvania	256,535	86,591	177,194	97,255	137,181
Missouri	1,389,552	807,381	1,192,029	1,555,266	1,866,469
Georgia	3,103,447	271,485	375,913	289,557	1,866,469
Louisiana	415,822	737,161	736,828	414,881	464,103
Washington	1,398,097	1,051,705	684,265	3,128,823	473,060
Tennessee	4,701,771	745,610	802,995	896,733	210,089
Alabama	543,570	881,510	6,928,825	587,432	518,403
Virginia	2,012,592	1,160,640	775,975	5,156,549	557,480
Iowa	94,850	261,400	37,500	64,162	58,492
Oklahoma	162,990	318,410	197,085	210,790	227,801
Indiana	186,200	219,645	134,590	277,842	845,367
Mississippi	135,518	159,290	164,125	115,660	113,772
Maryland	1,129,302	1,391,539	1,498,534	3,186,946	1,299,150
Arkansas	319,400	257,263	258,110	117,250	294,551
Total	38,721,088	35,038,306	40,422,374	39,185,172	31,307,448

Average Damage per Boat For The Top 25 States &

The States Chosen By GLIC:

	Losses	Per Boat	Covered States
Florida	$8,159,779.80	$8.86	
California	3,422,620.40	3.68	
Michigan	849,971.40	0.87	0.87
Minnesota	434,481.40	0.52	0.52
Wisconsin	558,641.20	0.92	0.92
Texas	794,145.00	1.28	
New York	1,399,047.00	2.68	
South Carolina	432,041.60	1.11	
Ohio	623,150.60	1.50	1.50
Illinois	297,300.80	0.78	0.78
North Carolina	742,128.00	2.08	
Pennsylvania	150,951.20	0.42	
Missouri	1,362,139.40	4.14	
Georgia	1,181,374.20	3.65	
Louisiana	553,759.00	1.76	
Washington	1,347,190.00	5.10	
Tennessee	1,471,439.60	5.60	
Alabama	1,891,948.00	7.17	
Virginia	1,932,647.20	7.99	
Iowa	103,280.80	0.46	
Oklahoma	223,415.20	1.00	
Indiana	332,728.80	1.54	1.54
Mississippi	137,673.00	0.59	
Maryland	1,701,094.20	8.41	
Arkansas	249,314.80	1.26	
Average	1,214,090.50	2.94	1.02

The 5 Types Of Accidents That Occur Most Frequently & The Top 10 Contributing Factors:

Top Five Types Of Accidents	Accidents	% Of Total
1. Collision With Vessel	1378	42.03%
2. Falls Overboard	498	15.19%
3. Collision With Fixed Object	497	15.16%
4. Skier Mishap	464	14.15%
5. Capsizing	442	13.48%
Total	3279	100.00%

Top Ten Contributing Factors	Accidents	% Of Total
1. Careless/Reckless Operation	639	16.49%
2. Operator Inattention	568	14.66%
3. Excessive Speed	432	11.15%
4. Operator Inexperience	429	11.07%
5. Passenger/Skier Behavior	384	9.91%
6. Alcohol Use	366	9.45%
7. Hazardous Waters	327	8.44%
8. No Proper Lookout	314	8.10%
9. Machinery System Failure	273	7.05%
10. Weather	143	3.69%
Total	3875	100.00%

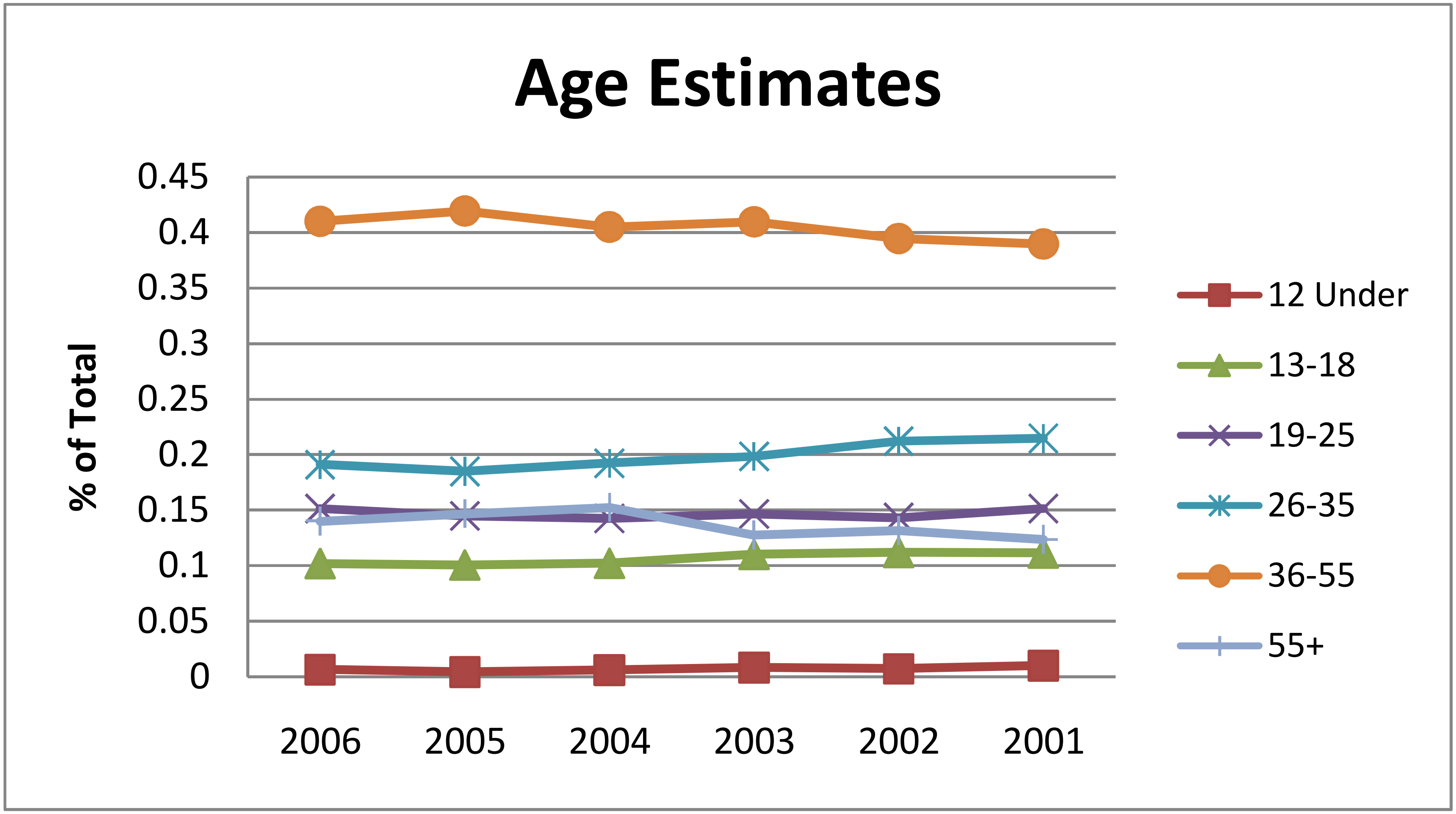
Accidents and Losses Separated By Primary Cause Of Accident From 2001-2005:

Boating Accidents:	2005		2004		2003		2002		2001	
Capsizing	442	$2,937,562.00	393	$2,267,043.00	514	$3,167,989	458	$2,344,033.00	466	$1,554,496
Carbon Monoxide Exposure	14	0.00	12	0.00	20					
Collision With Fixed Object	497	4,534,455.00	525	4,271,785.00	558	4,751,034.00	605	4,370,191.00	644	3,762,104.00
Collision With Floating Object	128	1,262,255.00	95	499,692.00	152	1,123,884.00	130	734,694.00	109	322,023.00
Collision With Vessel	1,378	10,559,219.00	1,479	8,037,552.00	1,469	7,474,678.00	1,704	8,295,659.00	2,062	8,997,570.00
Departed Vessel (Not Specified)	22	0.00	19	85.00	45	0.00	39			
Departed Vessel (Repairs)	2	400.00	2	0.00						
Departed Vessel (Retrieval)	4	0.00	5	0.00						
Departed Vessel (Swimming)	23	0.00	21	1,000.00						
Ejected From Vessel	16	75,000.00	45	244,500.00	7		16	26,100.00		
Electricution			4	12,000.00						
Falls/Impact In Boat	47	10,600.00								
Falls In Boat	210	110,200.00	176	106,496.00	233	183,400.00	256	35,620.00	284	48,685.00
Falls On Vessel			50	27,443.00						
Falls On PWC					15					
Falls Overboard	498	487,895.00	488	288,205.00	509	141,018.00	542	627,960.00	514	313,789.00
Fire/Explosion (Fuel)	141	7,811,354.00	162	8,297,780.00	142	2,921,295.00	160	11,164,927.00	153	3,179,323.00
Fire/Explosion (Other Than Fuel)	57	2,115,731.00	56	2,462,181.00	68	9,189,282.00	77	3,552,150.00	112	3,001,106.00
Flooding/Swamping	224	2,063,350.00	257	1,853,848.00	274	2,383,566.00	284	2,091,962.00	339	2,138,094.00
Grounding	291	2,778,913.00	215	2,488,744.00	291	4,282,148.00	340	2,739,601.00	412	3,792,817.00
Other	40	155,205.00	69	93,200.00	80	177,900.00				
Sinking	125	1,500,542.00	131	2,507,989.00	128	2,021,308.00	128	1,681,948.00	150	1,855,357.00
Skier Mishap	464	6,550.00	380	25,050.00	451	13,001.00	469	9,200.00	439	2,200.00
Struck By Boat	68	64,625.00	108	158,719.00	89	116,350.00	101	96,125.00	166	827,502.00
Struck By Motor/Propeller	100	13,390.00	64	500.00	107	350.00	90	10,800.00	100	15,701.00
Struck Submerged Object	141	1,609,891.00	102	974,112.00	128	1,446,179.00	110	954,582.00	128	801,966.00
Unknown	37	623,951.00	46	420,378.00	158	1,028,992.00	196	449,620.00	341	694,715.00
Total	4,969	38,721,088.00	4,904	35,038,302.00	5,438	40,422,374.00	5,705	39,185,172.00	6,419	31,307,448.00

Operator Risk Characteristics and Weighted Average: Age

Age: Estimates	2006	2005	2004	2003	2002	2001
12 & Under	33	23	33	51	48	76
13-18	530	550	558	671	752	840
19-25	787	791	779	892	962	1142
26-35	994	1012	1052	1210	1426	1622
36-55	2133	2295	2214	2498	2654	2944
55+	729	804	834	778	885	934
Unknown	1547	1153	1255	1263	1180	1416
Total (Unknown Exclusive)	5206	5475	5470	6100	6727	7558

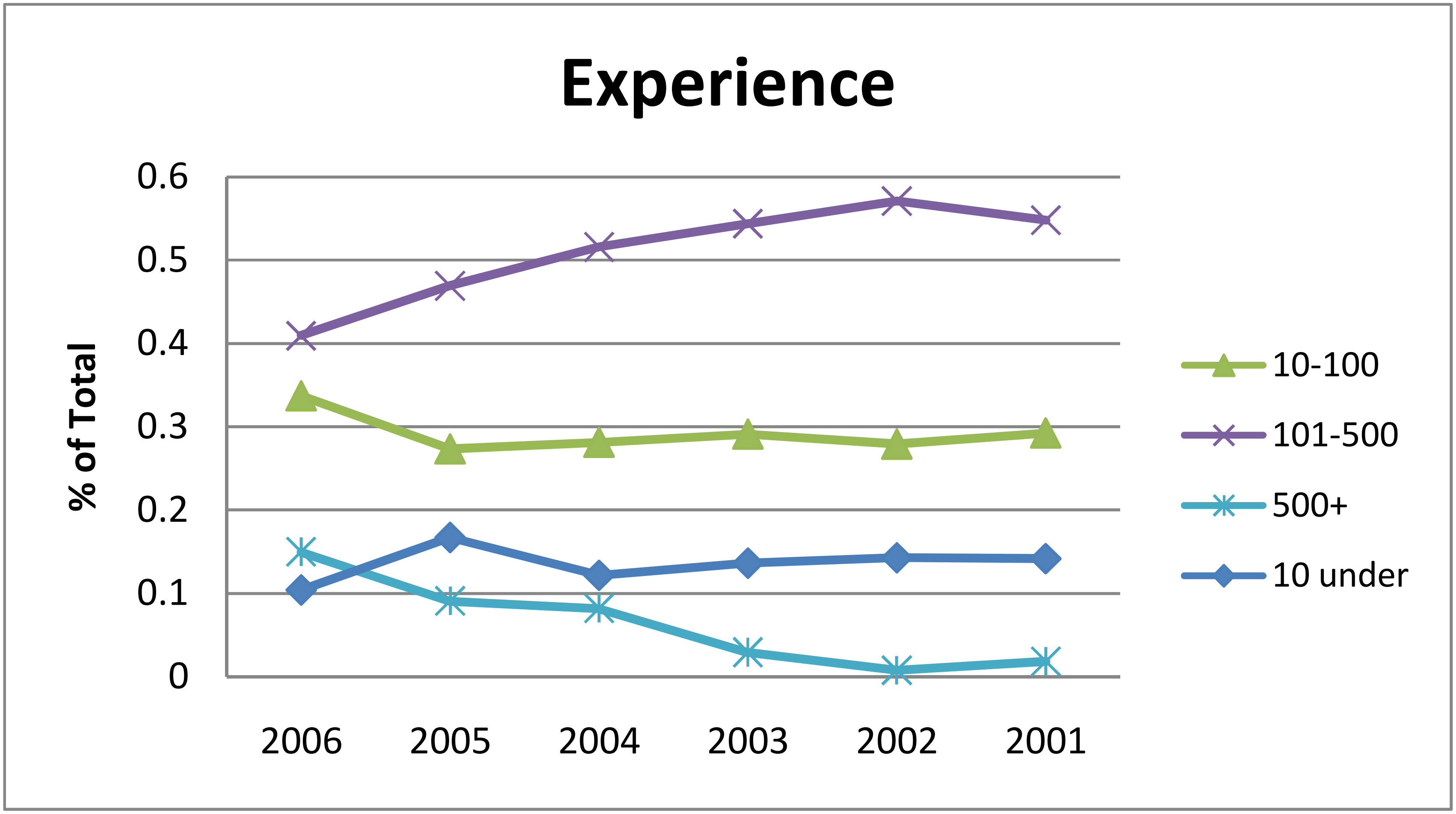
Age: Estimates	2006	2005	2004	2003	2002	2001	Average	Weighted Average
Weights	*6*	*5*	*4*	*3*	*2*	*1*		
12 & Under	0.63%	0.42%	0.60%	0.84%	0.71%	1.01%	0.70%	0.63%
13-18	10.18%	10.05%	10.20%	11.00%	11.18%	11.11%	10.62%	10.41%
19-25	15.12%	14.45%	14.24%	14.62%	14.30%	15.11%	14.64%	14.64%
26-35	19.09%	18.48%	19.23%	19.84%	21.20%	21.46%	19.88%	19.39%
36-55	40.97%	41.92%	40.48%	40.95%	39.45%	38.95%	40.45%	40.86%
55+	14.00%	14.68%	15.25%	12.75%	13.16%	12.36%	13.70%	14.06%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%


Age Estimates
% of Total
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2006
2005
2004
2003
2002
2001
12 Under
13-18
19-25
26-35
36-55
55+

Experience:

Experience: Hours	2006	2005	2004	2003	2002	2001
10 Under	410	788	494	709	839	951
10-100	1331	1289	1270	1546	1641	1850
101-500	1616	2212	2328	2887	3355	3678
500+	590	427	369	154	45	122
Unknown	2806	1877	2197	2042	2027	2259
Total	3947	4716	4516	5310	5880	6715

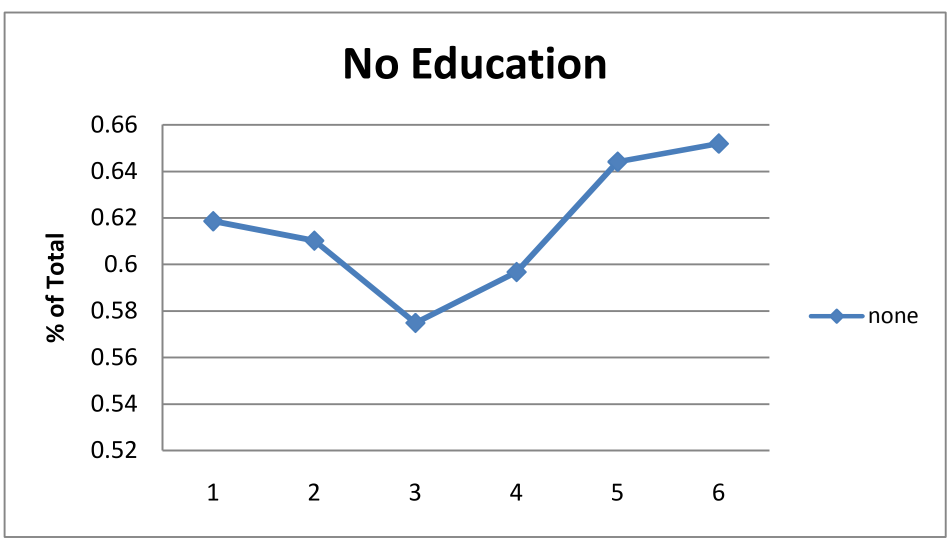
Experience: Hours	2006	2005	2004	2003	2002	2001	Average	Weighted Average
Weights	*6*	*5*	*4*	*3*	*2*	*1*		
10 Under	10.39%	16.71%	12.16%	13.62%	14.27%	14.16%	13.55%	13.24%
10-100	33.72%	27.33%	28.12%	29.11%	27.91%	29.24%	29.24%	29.71%
101-500	40.94%	46.90%	51.55%	54.37%	57.06%	50.93%	50.93%	48.49%
500+	14.95%	9.05%	8.17%	2.90%	0.77%	6.28%	6.28%	8.56%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

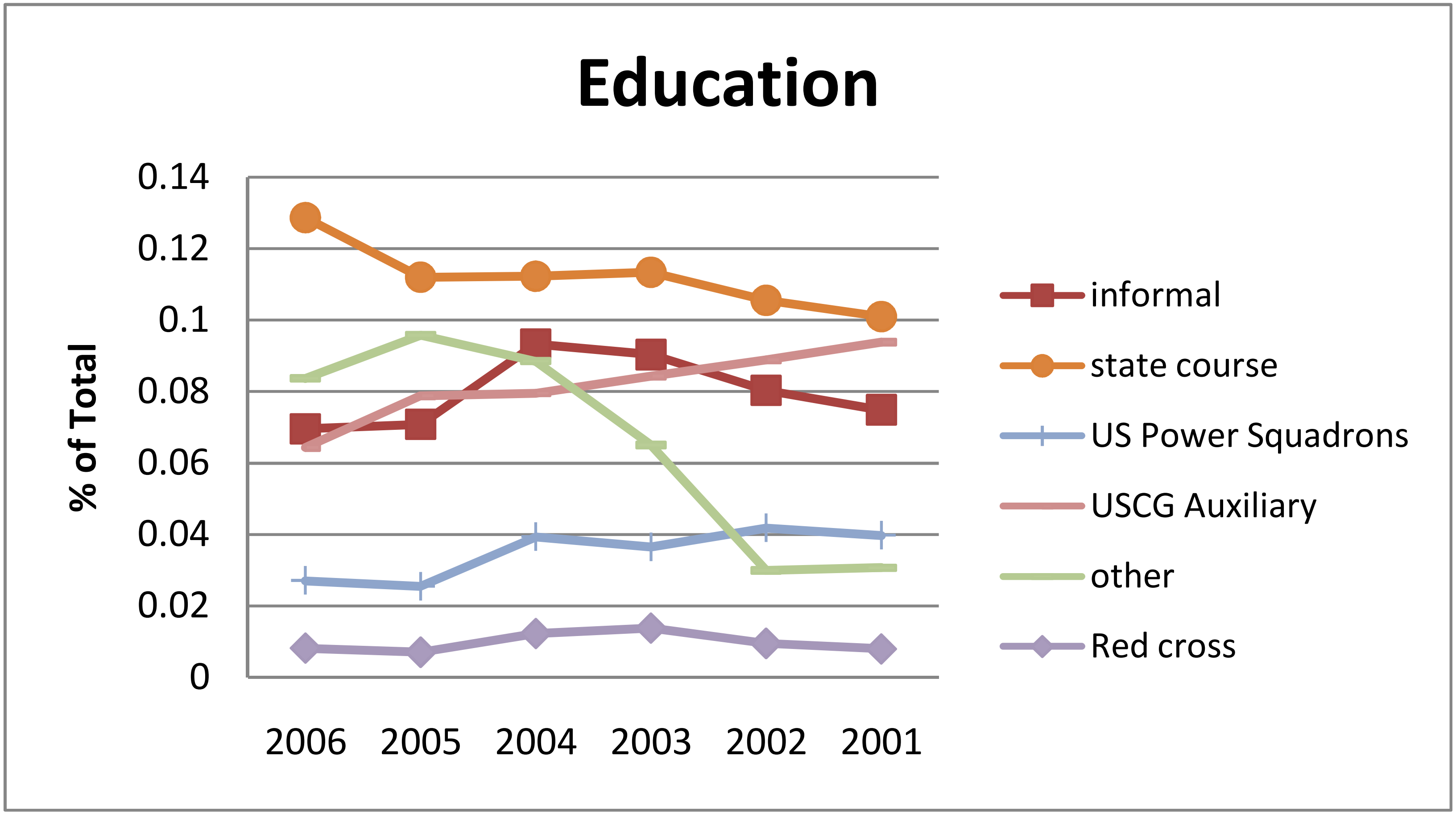

Experience
% of Total
0.6
0.5
0.4
0.3
0.2
0.1
0
2006
2005
2004
2003
2002
2001
10-100
101-500
500+
10 under

Education:

Education: Type	2006	2005	2004	2003	2002	2001	Fatalities
None	2587	2975	2442	2816	3130	3640	253
Informal	291	345	396	426	390	418	18
State Course	538	546	477	535	513	564	27
US Power Squadrons	113	124	167	172	203	222	5
USCG Auxiliary	269	384	338	398	432	524	8
Other	350	467	376	307	145	171	43
Red Cross	34	34	52	65	46	44	N/A
Unknown	2571	1753	2477	2644	3048	3391	N/A
Total	4182	4875	4248	4719	4859	5583	354

Age: Estimates	2006	2005	2004	2003	2002	2001	Average	Weighted Average
Weights	*6*	*5*	*4*	*3*	*2*	*1*		
None	61.86%	61.03%	57.49%	59.67%	64.42%	65.20%	61.61%	60.92%
Informal	6.96%	7.08%	9.32%	9.03%	8.03%	7.49%	7.98%	7.86%
State Course	12.86%	11.20%	11.23%	11.34%	10.56%	10.10%	11.22%	11.59%
US Power Squadrons	2.70%	2.54%	3.93%	3.64%	4.18%	3.98%	3.50%	3.23%
USCG Auxiliary	6.43%	7.88%	7.96%	8.43%	8.89%	9.39%	8.16%	7.73%
Other	8.37%	9.58%	8.85%	6.51%	2.98%	3.06%	6.56%	7.72%
Red Cross	0.81%	0.70%	1.22%	1.38%	0.95%	0.79%	0.97%	0.96%
Unknown	61.86%	61.03%	57.49%	59.67%	64.42%	65.20%	61.61%	60.92%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%





Education
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
% of Total
2006
2005
2004
2003
2002
2001
informal
state course
US Power Squadrons
USCG Auxiliary
other
Red cross

Operator Risk & Boat Risk Calculation Template: Example

Selection Area:

Education:	US Squadrons	Power
Age:	55+	
Experience:	500 Over	
Points:	6	
Boat Type:	Motorboat	
Rates:		
Reference Number	35.775%	
Education Multiplier	44.33%	
Age Multiplier	45.57%	
Experience Multiplier	17.42%	
Point Multiplier	100.00%	
OR Multiplier	100.3%	
Boat Multiplier	100.00%	
Total Multiplier	100.3%	

Selection Factors for the Risk Template:

Lessons:

-Select-		Fatality
None	104.43%	109.61%
Informal	145.84%	105.12%
State Course	104.64%	106.19%
US Power Squadrons	44.33%	31.08%
USCG Auxiliary	62.12%	28.73%
Other	133.57%	219.53%

Age:

-Select-	
12 Under	64.26%
13-18	303.66%
19-25	340.02%
26-35	132.27%
36-55	89.69%
55+	45.57%

Point Value:

1	-25.00%
2	-20.00%
3	-15.00%
4	-10.00%
5	-5.00%
6	0
7	5.00%
8	10.00%
9	15.00%
10	20.00%
11	25.00%
12	30.00%
13	35.00%
14	40.00%
15	45.00%
16	50.00%
17	55.00%
18	60.00%
19	65.00%
20	70.00%

Experience:

-Select-	
10 Less	151.961%
10-100	125.741%
101-500	195.978%
500 Over	17.423%

Boat Type

-Select-	
Motorboat	100.00%
PWC	84.15%
Sailboat	91.46%

Calculating the severity of each type of Accident:

2004-2006 TOTAL	Accidents	PROPERTY DAMAGE	PROB/YEAR	Average Damage	Significant Factors
TOTAL	4947	$39,143,273	0.0390%	$7913	1.20
Capsizing	430	2,316,268	0.0036%	5386	0.81
Carbon Monoxide Exposure	15	33,167	0.0001%	2261	0.34
Collision w/ Fixed Object	513	4,626,426	0.0041%	9018	1.36
Collision w/ Floating Object	122	1,004,667	0.0011%	8257	1.25
Collision w/ Vessel	1406	9,374,610	0.0107%	6669	1.01
Departed Vessel	15	$28	0.0000%	1	0.00
Ejected from Vessel	34	261,024	0.0003%	7753	1.17
Fall In Boat	141	68,440	0.0016%	486	0.00
Fall On Boat	96	48,231	0.0002%	500	0.00
Falls Overboard	490	380,005	0.0038%	774	0.00
Fire or Explosion of Fuel	148	7,377,366	0.0011%	49847	2.50
Fire or Explosion - Other	59	5,090,574	0.0005%	86771	2.50
Flooding/Swamping	232	2,004,350	0.0017%	8627	1.30
Grounding	253	2,688,285	0.0020%	10639	1.61
Other Casualty	70	138,914	0.0008%	1984	0.00
Sinking	123	2,221,889	0.0009%	18015	2.72
Skier Mishap	451	11,134	0.0040%	24	0.00
Struck by Boat	81	81,582	0.0005%	1011	0.00
Struck by Motor/Propeller	90	11,063	0.0008%	122	0.00
Struck Submerged Object	110	1,045,487	0.0007%	9533	1.44
Unknown	35	355,293	0.0002%	10055	0.00

Weighted averages for the number of accidents per accident type for motorboats:

2006 TOTAL ACCIDENTS BY ACCIDENT TYPE	2006	2,005	2,004	WEIGHTED AVERAGE
TOTAL	4,292	3,415	4,309	4,004
Capsizing	266	200	245	238
Carbon Monoxide Exposure	15	11	11	13
Collision w/ Fixed Object	431	302	439	390
Collision w/ Floating Object	138	101	83	111
Collision w/ Vessel	1,446	1,129	1,588	1,378
Departed Vessel	38	28	43	36
Ejected from Vessel	18	6	33	18
Fall In Boat	155	134	134	142
Fall On Boat	1	0	3	1
Falls Overboard	271	248	294	269
Fire or Explosion of Fuel	137	124	159	139
Fire or Explosion - Other	100	43	58	70
Flooding/Swamping	192	178	233	198
Grounding	219	214	186	209
Other Casualty	86	25	60	59
Sinking	102	75	124	99
Skier Mishap	438	342	353	383
Struck by Boat	37	41	72	48
Struck by Motor/Propeller	107	81	62	86
Struck Submerged Object	80	117	93	96
Unknown	15	16	36	21

Weighted averages for the number of accidents per accident type for PWCs

2006 TOTAL ACCIDENTS BY ACCIDENT TYPE	2006	2,005	2,004	WEIGHTED AVERAGE
TOTAL	1,777	1,795	1,767	1,780
Capsizing	37	32	19	31
Carbon Monoxide Exposure	2	1	1	1
Collision with Fixed Object	112	101	79	100
Collision with Floating Object	51	31	23	37
Collision with Vessel	1,123	1,151	1,173	1,146
Departed Vessel	1	2	0	1
Ejected from Vessel	19	11	13	15
Fall In Boat	41	48	48	45
Fall On Boat	28	49	55	42
Falls Overboard	152	153	143	150
Fire or Explosion of Fuel	23	14	16	18
Fire or Explosion - Other	3	5	1	3
Flooding/Swamping	12	14	23	16
Grounding	23	34	20	26
Other Casualty	19	5	16	14
Sinking	9	7	6	8
Skier Mishap	49	61	38	50
Struck by Boat	53	36	80	55
Struck by Motor/Propeller	8	2	1	4
Struck Submerged Object	4	29	5	13
Unknown	8	9	7	8

Weighted averages for the number of accidents per accident type for Sailboats:

2006 TOTAL ACCIDENTS BY ACCIDENT TYPE	2006	2,005	2,004	WEIGHTED AVERAGE
TOTAL	93	103	158	114
Capsizing	22	19	23	21
Carbon Monoxide Exposure	0	0	0	0
Collision with Fixed Object	1	8	18	8
Collision with Floating Object	5	1	1	3
Collision with Vessel	42	41	88	54
Departed Vessel	0	2	0	1
Ejected from Vessel	0	0	1	0
Fall In Boat	4	3	0	3
Fall On Boat	0	0	0	0
Falls Overboard	8	10	7	8
Fire or Explosion of Fuel	0	1	1	1
Fire or Explosion - Other	1	0	2	1
Flooding/Swamping	3	2	3	3
Grounding	5	10	6	7
Other Casualty	1	0	4	1
Sinking	1	0	0	0
Skier Mishap	0	0	0	0
Struck by Boat	0	3	2	2
Struck by Motor/Propeller	0	1	0	0
Struck Submerged Object	0	1	1	1
Unknown	0	1	1	1

Evaluation of the Boat Risk Value for PWCs and the calculations for the average accident rate:

Accident Type	Propeller	Water Jet/ PWC	% for Propeller	% for PWC	Relative Accident Rate PWC: propeller	Accident Severity	Weighted Severity Factors	Severity Factors (weighted chance/ year)
TOTAL	4,004	1,780						
Capsizing	238	31	5.94%	1.74%	29.30%	0.81	23.84%	0.42%
Carbon Monoxide Exposure	13	1	0.32%	0.06%	17.30%	0.34	5.91%	0.00%
Collision w/ Fixed Object	390	100	9.74%	5.62%	57.68%	1.36	78.58%	4.41%
Collision w/ Floating Object	111	37	2.77%	2.08%	74.98%	1.25	93.54%	1.94%
Collision w/ Vessel	1,378	1,146	34.42%	64.38%	187.07%	1.01	188.49%	121.35%
Departed Vessel	36	1	0.90%	0.06%	6.25%	0.00	0.00%	0.00%
Ejected from Vessel	18	15	0.45%	0.84%	187.45%	1.17	219.57%	1.85%
Fall In Boat	42	45	1.05%	2.53%	241.01%	0.00	0.00%	0.00%
Fall On Boat	1	42	0.02%	2.36%	9447.64%	0.00	0.00%	0.00%
Falls Overboard	269	150	6.72%	8.43%	125.43%	0.00	0.00%	0.00%
Fire/Explosion -Fuel	139	18	3.47%	1.01%	29.13%	2.50	72.82%	0.74%
Fire/Explosion - Other	70	3	1.75%	0.17%	9.64%	2.50	24.10%	0.04%
Flooding/ Swamping	198	16	4.95%	0.90%	18.18%	1.30	23.69%	0.21%
Grounding	209	26	5.22%	1.46%	27.98%	1.61	44.98%	0.66%
Other Casualty	59	14	1.47%	0.79%	53.38%	0.00	0.00%	0.00%
Sinking	99	8	2.47%	0.45%	18.18%	2.50	45.44%	0.20%
Skier Mishap	383	50	9.57%	2.81%	29.37%	0.00	0.00%	0.00%
Struck by Boat	48	55	1.20%	3.09%	257.75%	0.00	0.00%	0.00%
Struck by Motor/Propeller	86	4	2.15%	0.22%	10.46%	0.00	0.00%	0.00%
Struck Submerged Object	96	13	2.40%	0.73%	30.46%	1.44	43.87%	0.32%
Unknown	21	8	0.52%	0.45%	85.69%	0.00	0.00%	0.00%
Registration	7,724,530	3,128,965					Motorboat Risk Factor	132.15%
Accident Rate	0.05%	0.05%						
Adjusted accident rate	1.04%	1.04%						

Evaluation of the Boat Risk Value for Sailboats:

Accident Type	Propeller	Water Jet/ PWC	% for Propeller	% for PWC	Relative Accident Rate PWC: propeller	Accident Severity	Weighted Severity Factors	Severity Factors (weighted chance/ year)
TOTAL	4,004	114						
Capsizing	238	21	5.94%	18.42%	309.91%	0.81	252.18%	46.45%
Carbon Monoxide Exposure	13	0	0.32%	0.00%	0.00%	0.34	0.00%	0.00%
Collision with Fixed Object	390	8	9.74%	7.02%	72.05%	1.36	98.16%	6.89%
Collision with Floating Object	111	3	2.77%	2.63%	94.93%	1.25	118.42%	3.12%
Collision with Vessel	1,378	54	34.42%	47.37%	137.64%	1.01	138.68%	65.69%
Departed Vessel	36	1	0.90%	0.88%	97.56%	0.00	0.00%	0.00%
Ejected from Vessel	18	0	0.45%	0.00%	0.00%	1.17	0.00%	0.00%
Fall In Boat	42	3	1.05%	2.63%	250.88%	0.00	0.00%	0.00%
Fall On Boat	1	0	0.02%	0.00%	0.00%	0.00	0.00%	0.00%
Falls Overboard	269	8	6.72%	7.02%	104.45%	0.00	0.00%	0.00%
Fire or Explosion of Fuel	139	1	3.47%	0.88%	25.27%	2.50	63.17%	0.55%
Fire or Explosion - Other	70	1	1.75%	0.88%	50.18%	2.50	125.44%	1.10%
Flooding/Swamping	198	3	4.95%	2.63%	53.22%	1.30	69.36%	1.83%
Grounding	209	7	5.22%	6.14%	117.64%	1.61	189.08%	11.61%
Other Casualty	59	1	1.47%	0.88%	59.53%	0.00	0.00%	0.00%
Sinking	99	0	2.47%	0.00%	0.00%	2.72	0.00%	0.00%
Skier Mishap	383	0	9.57%	0.00%	0.00%	0.00	0.00%	0.00%
Struck by Boat	48	2	1.20%	1.75%	146.35%	0.00	0.00%	0.00%
Struck by Motor/Propeller	86	0	2.15%	0.00%	0.00%	0.00	0.00%	0.00%
Struck Submerged Object	96	1	2.40%	0.88%	36.59%	1.44	52.69%	0.46%
Unknown	21	1	0.52%	0.88%	167.25%	0.00	0.00%	0.00%
Registration	7,724,530	3,128,965					Sailboat Risk Factor	137.70%
Accident Rate	0.05%	0.05%						
Adjusted accident rate	1.04%	1.04%						