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Woods Hole Oceanographic Institution

The Environmental Impacts of Boating; Proceedings of a Workshop held at Woods Hole Oceanographic Institution, Woods Hole MA USA December 7 to 9, 1994.

Edited by: Richard E. Crawford, Nils E. Stolpe and Michael J. Moore

March 1998

Technical Report

Approved for public release; distribution unlimited.

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Woods Hole, Massachusetts 02543

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Approved for Distribution:

Wayne R. Geyer
Director, Rinehart Coastal Research Center

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The editors thank the presenters and participants of the workshop as well as Bebe McCall and Bruce Tripp of the Gratia Houghton Rinehart Coastal Research Center and Dery Bennet of the American Littoral Society for their gracious help in achieving a successful meeting. Transcripts of the presentations were prepared by Maureen Pires, Verbatim Court Reporter (508-748-2857), and then edited for these proceedings by Richard Crawford, of the Waquoit Bay National Estuarine Research Reserve and who bears primary responsibility for any inaccuracies in assembling this document. Nils Stolpe, a private consulting expert in boating and marine issues and Michael Moore of the Woods Hole Oceanographic Institution also assisted in editing. Bebe McCall transformed a rough text version of this document into its final form. Unedited verbatim transcripts of the meeting's presentations are available on diskette from Michael Moore, MS 33, WHOI, Woods Hole, MA 02543.

The editors also thank Bruno Broughton of Ruddington, Nottingham (England) and Bradley Barr of the Massachusetts Office of Coastal Zone Management (presently with the Gerry Studds Stellwagen Bank National Marine Sanctuary) for sharing bibliographies and files relating to boating impacts literature. Although much of this literature is dated and unpublished, the references were compiled into bibliographies by R. Crawford as appendices in this report.

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Executive Summary

Substantiated impacts of boating activity that were discussed at this workshop include: sediment and contaminant resuspension and resultant turbidity; laceration of aquatic vegetation with loss of faunal habitat and substrate stability; toxic effects of chemical emissions of boat engines; increased turbulence; shearing of plankton; shorebird disturbance; and the biological effects of chemically treated wood used in dock and bulkhead construction. These discussions revealed that many of the issues of concern remain inadequately defined and described. But sufficient hard data was referred to or presented to substantiate the inference that recreational and commercial motor boat operation is far from a benign influence on aquatic and marine environments. This is particularly so in temperate climes due to the unfortunate synchrony, with only a few exceptions, between the peak seasons for boating and the occurrence of planktonic embryonic and larval stages of vertebrates and invertebrates in estuaries and coastal waters. Therefore, the chance of plants and organisms being affected by power boat operation appears to be substantial in shallow, heavily used boating areas such as those along the entire U.S. eastern and Gulf coasts. As such, motor boat operation ought to be regarded as a privilege which requires due consideration of environmental impacts, and should be conducted and managed in such a manner as to minimize those impacts.

Introduction

This workshop was born from the interest of an informal network of concerned individuals. The meeting was conceived to be more than simply a data workshop, a character that is reflected in this document. Instead, the meeting was intended to be a time to share data and discuss hypotheses and speculations. The object of the discussions was to consider the jigsaw puzzle of potential impacts of boats in the aquatic environment. It was recognized that workshop results would not represent definitive descriptions of boating impacts. Instead it was hoped that the meeting would define some of the boundaries of the impacts jigsaw puzzle. At the same time, it was acknowledged that many of the puzzle pieces would be left in outline form.

The steering committee invited representatives from industry, government, science and the environmental lobby to the workshop. The attendees included administrators, consultants, writers, economists, research scientists and environmental advocates. The only invited group that chose not to attend the meeting was industry.

Our charge at the workshop was to examine boating activities in different habitats according to the spectrum of no impact to high impact, to consider what are the best indicators to measure those impacts, and to begin to focus on the critical agents of change. This approach is illustrated by a brief case study where there is little question of boating having a severe impact in the Norfolk Broads in England. There, about 250 miles of rivers run through a series of medieval

peat diggings that make broad lakes anything up to a mile or two in length. The banks of the rivers are peat, and the bottoms soft mud. Seasonal rental power boats cause massive traffic problems as well as bank erosion, turbidity, macrophyte shearing, chronic habitat disturbance, noise, and pollution from boat sewage. Solutions have been hard to find, as the local economy is heavily tourist dependent. Speed limits, pump-outs and bulkheads on the river banks are the primary management tools currently in evidence. In spite of the fact that boating activity has an evident impact in that region, there is insufficient definitive understanding of how boating affects shallow systems to help planners and managers design additional measures that would help to minimize environmental consequences while allowing boating activity to continue. It was the hope of workshop organizers that the discussions at this meeting would provide kernels for the efforts of the diverse group of attendees to help design such measures.

The agenda of the workshop was to hear perspectives from managers, economists, statisticians, and scientists on the issues at hand: the biological, physical and chemical effects of recreational boating activity as it relates to hulls of pleasure craft being propelled through the water. We intentionally avoided the separate issue of boat sewage discharge as it is a separate workshop unto itself. The deliberations were to be rational and based on science, rather than foregone conclusions.

At the conclusion of the formal presentations, participants were to gather into groups to discuss the issues that were raised as well as related issues that were not, and generate working statements relevant to these goals. The general theme of each working group was to be decided at the conclusion of the presentations. The themes would reflect the issues that had received the most emphasis in both the formal presentations as well as during the question-and-answer period that followed each presentation. The participants in the working groups were charged with the following questions:

- What do we know?
- What do we not know but need to?
- What research is currently in progress?
- What research collaborations should be established?
- Where should funds be sought to pursue these goals?
- Which issues are, can and should be managed by legislation?
- What is an appropriate legislative agenda at the national and state level?

The proximate goal of the workshop was to generate a working document to define issues relevant to the effects of boating activities. In spite of the fact that the study of boating impacts is in its early stages, there is a substantial body of literature, much of it from England, that is relevant to the issues discussed here. Workshop participants were to review what is known and to chart research and management needs and how these might be addressed. Our ultimate goal was to

focus academic, political and legislative consciousness toward boating-related issues that may be damaging to the health of our coastal and freshwater ecosystems and consequently damaging to the long term viability of regional economies.

This document is an edited proceedings of the workshop. Some of the presentations were reports of new information about well established, long known impacts such as turbidity and bird disturbance. Other topics, such as the toxic effect of engine exhaust and propeller shearing questions, have been little studied in the boating context. Because of the embryonic nature of many of the ideas discussed at the workshop, it developed a somewhat fluid format that is reflected in these proceedings.

Some talks referred to visual material not included in these proceedings; several were not supported by written text other than abstracts. To enhance the readability of this document, the editors have taken editorial liberties to help convey the message of the author of a presentation. Most of the presentations are reported as edited versions of text submitted by the author or as edited transcripts of a verbatim recording. Appropriate unedited tables and figures are included, if available. The presentation by George McCarthy was supported by text taken from a more formally structured manuscript under development for subsequent publication elsewhere. A synopsis of this text has been included in this proceedings. When data from completed studies was mentioned in a talk, appropriate references are given in this compilation. Several bibliographies of literature pertinent to the topics discussed at the workshop are included in the Appendices.

The contents of this proceedings are to be considered descriptions of works-in-progress. They cannot be cited without the permission of the authors of the various presentations. As noted in the Acknowledgments section, unedited transcripts of the presentations are available from Michael Moore, MS 31, WHOI, Woods Hole, MA 02543.

In editing these transcripts we have forgone efforts to maintain the character of the presenters' individual manners of speech in favor of producing a document with consistent style and format. The exception is the Question and Answer sessions. These have been included in a modestly edited form to retain the deportment of the discussions, a fundamental element of the future of the issues forming the crux of the workshop. The sequential order of the papers has been reorganized from that of the workshop to better maintain a logical format within this document. We hope that this report will be used as a source of discussion to stimulate new research ideas and generate new management concerns and/or plans in those instances when the material is relevant.

In this regard, the findings of the working groups provide useful overviews of what we know and what we need to know. Toward this end, one of the most remarkable aspects of this workshop was the revelation of the greater activity and knowledge base of many state-level environmental managers than that for members of the academic and research communities. This in

part reflects the applied nature of the issues but it also points to a real need for increased funding for research in all of the areas considered at the workshop, an appraisal which is described in greater detail in these proceedings.

Biological Profile Of A "Typical" Estuary

Jim Joseph
Division of Fish, Game and Wildlife, New Jersey Department of Environmental Protection, Trenton, NJ

Coastal wetlands adjacent to estuaries are very productive—an ecological soup containing phytoplankton, zooplankton and various life stages of fish, crustaceans, polychaetes and mollusks. There was a tremendous amount of development pressure in the coastal zone prior to the development of a multitude of state and federal regulations regarding coastal development and wetlands protection. Waterfront development is rampant with tremendous amounts of dredging and filling of coastal areas to create lagoon developments in order to get every square inch along the shore, with resultant habitat destruction and degradation.

In New Jersey for example, between 1970 and 1990, while the total state population increased only about eight percent, the population of the coastal counties increased by 30, 60, and over 100 percent. So, there is a mad dash to the coast. All of these people moving to the shore want to have their boats, and that has created more problems for water quality, congestion, environmental disturbance and fishing pressure.

In New Jersey, and I am sure in most coastal areas, in estuaries on any given weekend day and even during the week in the summertime it is sometimes "wall-to-wall" boats involved with recreational fishing—individual boats and party boats that have large numbers of people.

This [slide] is an aerial shot of Delaware Bay on a weekend day. Each of those little white dots is not a whitecap but a boat being used for fishing, putting tremendous pressure on the resource from an ecological as well as an over-exploitation aspect.

In coastal zone and near shore waters there is also a lot of commercial fishing and related activity that creates other pollution problems which, whether they are from surf clam boats or draggers or otter trawlers, we are concerned about.

Another problem that is common along the coast is determining the causes of declining stocks. Is it the recreational guy taking all the fish; is it commercial draggers just vacuuming everything up; is it a combination of the two? The resulting conflicts are being resolved in a number of ways, primarily through screaming matches. But as more and more fisheries stocks are declining, government managers are looking at all possible causes. One of those being looked at, at least in New Jersey, and I am sure in other areas—and the purpose of this workshop—is boating and its impact on various life stages of fishes.

Estuarine juvenile and young-of-the-year fish and invertebrates have been studied by state and federal agencies and academic institutions by using various otter trawls, and seine plankton

and bongo nets. Typically, the younger stages—eggs and larvae—are more vulnerable to environmental disturbances, whether it is physical disturbance or elevated levels of hydrocarbons or heavy metals. A lot of the resource information that has been collected over the years by government and academic institutions was compiled and published in March of this year by NOAA's Estuarine Living Marine Resources Program. It documents the eggs and larvae in the estuaries of the Atlantic Coast states and the times of the year that they are present. The following important species have their embryonic and larval life stages between April and October (the precise timing depends on species and latitude): blue mussel, American oyster, hard clams, blue crab, blue-back herring, alewife, American shad, Atlantic menhaden, minnows, killifish, silversides, white perch, striped bass, black sea bass, tautog and Atlantic mackerel. In contrast, cod and winter flounder tend to spawn in the winter months.

Many of these fishery resources are experiencing stock declines, intensifying the need for more and more regulations to limit harvest and protect habitat and maintain our improved water quality. The state and federal governments have implemented various regulations and guidelines to allow development but with care to reduce environmental impacts. New Jersey has developed guidelines to steer marina development away from sensitive areas such as shellfish beds and submerged vegetation and toward areas with good flushing and deep water where dredging will not be required. The state also has incorporated best management practices to further reduce the impacts.

There has also been an extensive public education campaign to make members of the boating community more aware of their activities and how they can impact the coastal zone water quality in particular, whether with marine heads, bottom paints, or just plain litter. Via the Clean Vessel Act, New Jersey has established more and more pump-out stations to meet planning requirements for more No Discharge Zones to improve water quality in the estuary.

Coastal zone regulations in New Jersey are constantly being revised, sometimes to the dismay of the development interests. But some recent work by Dr. Weis [and Dr. Judith Weis] regarding pressure treated lumber, for example, has been incorporated into recent amendments to these regulations. In July of this year we adopted regulations precluding the use of pressure treated lumber in certain estuaries in New Jersey because of their impacts from new marina construction. Our coastal regulations are constantly being revised to address problems based on current information that is available.

In summary, the sensitive life stages occur in our estuaries basically from April through September or October. Unfortunately, that coincides fairly well with the boating season, at least in the Mid-Atlantic. There has been tremendous development pressure and tremendous declines in fisheries stocks. And in an effort to try and curb that, people are "pointing the finger". Whether it

is you are overfishing, or I am overfishing, or whether it is a pollution problem—all of these things are being addressed. I wanted to give you a feel for what is going on out there.

Q (by Michael Moore) Regarding all those different species, do you have any feeling for which species or groups of species in particular are most likely to be sensitive to entrainment and damage? This is a question that will be addressed later on, but I want your perspective on it.

A (by Jim Joseph) I don't. I work for the Bureau of Shellfisheries, and unfortunately, I have a kind of tunnel vision looking at clams and oysters. And there is a tremendous amount of information in the literature about the effects of petroleum hydrocarbons and copper bottom paints and things like that on the eggs, larvae and juveniles of hard clams, for examples, and oysters. So, they are very susceptible to those kinds of pollution. As for as other species, I am not that familiar with them.

Mr. Moore: The issue is a big one, but it has not really been addressed academically yet.

Mr. Joseph: If anybody is interested, this is a terrific publication. "Distribution and Abundance of Fishes and Invertebrates in Mid-Atlantic Estuaries," ELMR, which is Estuarine Living Marine Resources, Report #12, March, 1994. It lists most of the important species and at what life stages they are in the estuaries at different months of the year. It is a good reference source.

Q (by Nils Stolpe) Jim, are there any species that you are aware of that move up and down in the water column daily over a 24 hour period that their movement might make them less vulnerable to certain boating impacts during the day than at night.

A Yes, there is vertical migration for a number of species, but I could not give you specific ones. Most of the species we are concerned about during their relevant life stages are just free-drifting organisms that are pretty much everywhere throughout an estuary at a given period of time.

Q You said that the bass had semi-buoyant eggs?

A Yes.

Q When you say "semi-buoyant," does that mean that they move up and down or do they just kind of hang out at some depth?

A As opposed to a demersal egg that may be adhesive and stick to the bottom between rocks or something like that, it is a slightly negatively buoyant egg as opposed to one that is floating around and would go everywhere. So they tend to hang out along the bottom but would not just anchor themselves to the bottom.

Q In your experience in New Jersey, some of the boating impacts to shellfish, then inspecting seed beds, moorings and—

A Most of the problems that we experience in New Jersey are due to water quality degradation as it affects shellfish harvestability. There are fairly extensive regulations that prevent

new dredging and protect sensitive shallow water habitats, submerged vegetation beds and similar areas. Despite the regulations, we are constantly in court to fight those kinds of developments in sensitive areas.

I recently went through a regulatory challenge in New Jersey where people who were denied permits for docks had been suing the state and the Commissioner of the Department of Environmental Protection was getting intense pressure from the disgruntled applicants. I looked at the data, which showed that only nine percent of permit applications were being denied. We were only hearing from the nine percent who are dissatisfied, not the 91 percent who got their dock. Most of the dock applications are approved, but we are trying to steer them away from sensitive areas.

Q So, the pollutants you are dealing with are toxics rather than—

A Well, coliform contamination, petroleum hydrocarbons from boat operation, copper bottom paints, detergents, pressure treated lumber are a big concern. All those things are reviewed, but unfortunately, most of the regulations deal almost exclusively with coliform contamination and the potential for coliform contamination from boats.

Q And the major source for you is the marina? I mean, it seems that in Massachusetts coliform contamination is mostly a nonpoint source pollution problem.

A Yes, but we have got to start somewhere. And New Jersey is in the process of implementing a study looking at the environmental impact of individual docks. There has been a lot of data collected on marina situations. Dr. Weis, over the last two years, for example, has done some work with pressure treated lumber from individual structures. Because of the court cases that we have had to deal with, arguing that we can not use marina data to extrapolate from to prevent single dock construction, we are going to be looking at what those water quality impacts are for individual docks in mooring areas so that we can address that issue more precisely in the future.

National Recreational Boating Patterns

Nils E. Stolpe

3840 Terwood Drive, Doylestown, PA 18901

(Editors's note: The preponderance of this talk was based on visual aids in the form of several charts. Due to the high probability that much of the complex information contained within the charts would be lost in a copy of only the text of the talk, the figures used in the presentation have been included in this report.)

In an attempt to put this workshop in the proper context, I am going to give you a brief overview of recreational boating in the United States, of the size and importance of the recreational boating industry, and of what seem to be some developing trends in boating. First, some general industry information from the U.S.E.P.A. Draft Regulatory Impact Statement:

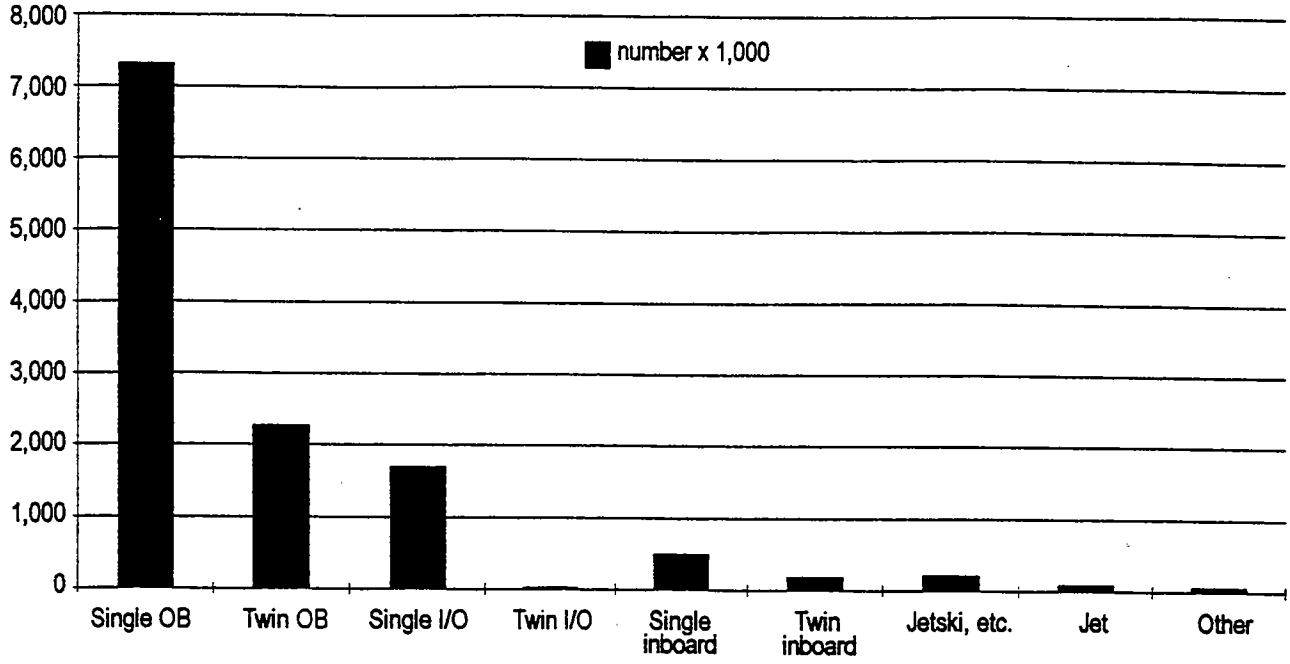
- In 1994, outboard motor manufacturing in the United States could reach $1 billion. This would represent a 12 percent annual increase in each of the previous two years. The production of inboard/outboard motors (also known as stern drives) is projected to reach $975 million, 34 percent below the level reached in 1984. Sailboat sales are expected to be $125 million. In 1993, the sale of personal water craft (jet skis, wave runners, etc.) was $618 million.
- From 1991 to 1994 total retail boat sales in the United States increased 20 percent. During the same period, the sales of personal watercraft increased 41 percent, making them — along with unpowered craft like kayaks and canoes — one of the fastest growing segments of the recreational boating market. Personal watercraft are driven by waterjets and are capable of operating in much shallower water than conventional powered craft. Because of this shallow water capability they have opened up many areas that had previously been off limits to powered craft.
- The boating industry is fairly well concentrated. Fifty-six percent of all the marinas in the U.S. are located in four states; eight states support almost _ of all the recreational boat dealers; almost 2/3 of all recreational boat manufacturing is done in ten states.

I do not want to get bogged down with an excess of numbers so I will go over the following graphs fairly rapidly. They are indicative of the general boating patterns that we see in the U.S., some of which might prove useful in any consideration of public policies focused on

boating regulations. Most of the data described in the graphs came from either the U.S. Fish and Wildlife Service's National Boating Survey or was compiled by the U.S. Environmental Protection Agency as it focused on emissions from boat engines and other previously unregulated sources, such as non-road surfaces. I do not know how rigorous these agencies were in accumulating the data; I would imagine not very.

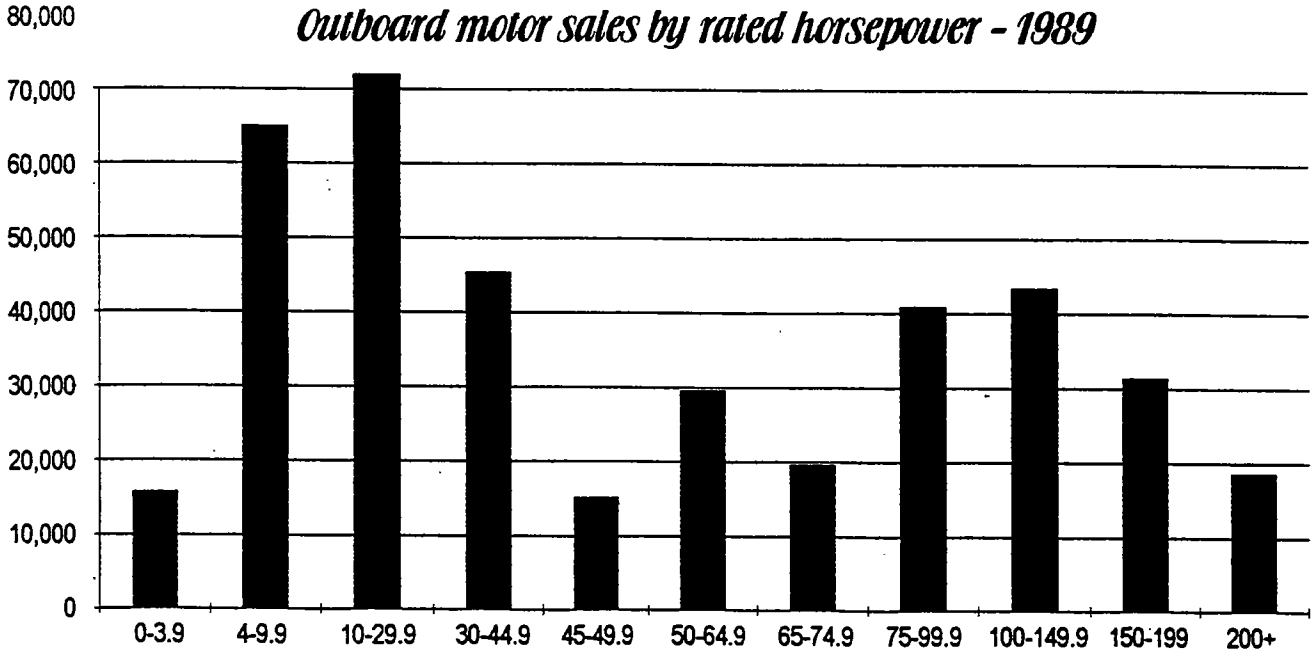
Tracking boating activities is a difficult task, in large part because of the "mobile" nature of many recreational boats and virtually all personal water craft; they are trailerable and can be used in waters far from where they are registered. Another factor could be the extremely long lives of fiberglass boats and modern outboard motors. A seemingly ancient boat in a backyard can still be serviceable [e.g., ready-to-go] with an up-to-date registration, even if the boat is rarely used. Finally, many members of the boating community evidently feel that our waterways are one of the last "frontiers" and that their use should remain free of the regulations and reporting that affect so many other activities. In spite of this, from a national perspective the information that is available gives us a reasonable idea of the large-scale characteristics of small boat use in the U.S. and of the potential scope of the impacts that we will be addressing over the next several days.

Vessels registered by propulsion type



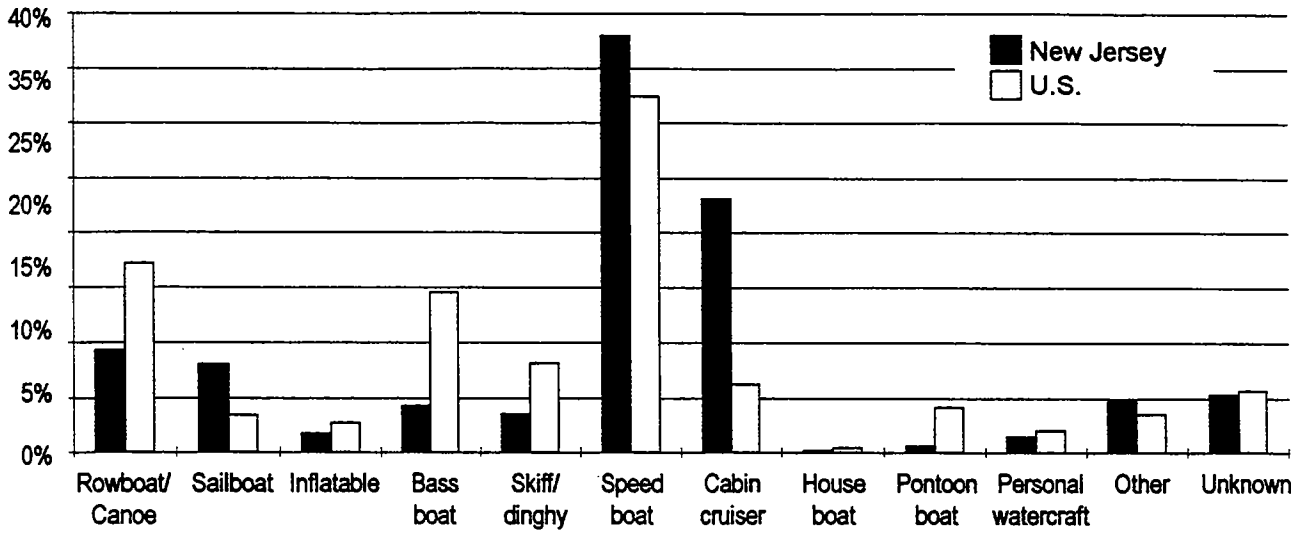
By an overwhelming majority, most powered vessels in the U.S. are driven by outboard motors. Presently about 99% of these motors are two cycle. While outboard motors are generally thought of as being smaller and used either as auxiliary motors on larger boats or as primary propulsion for smaller vessels, they can exceed 200 horsepower and are used - alone or in tandem - to power boats more than 30 feet in length. As the following graph shows, the "average" outboard motor sold in the U.S. in 1989 was 65 horsepower. This is all in marked contrast to the recreational boating picture in Europe, where large engines and 30+ mile an hour speeds are the exception rather than the rule.

Outboard motor sales by rated horsepower - 1989



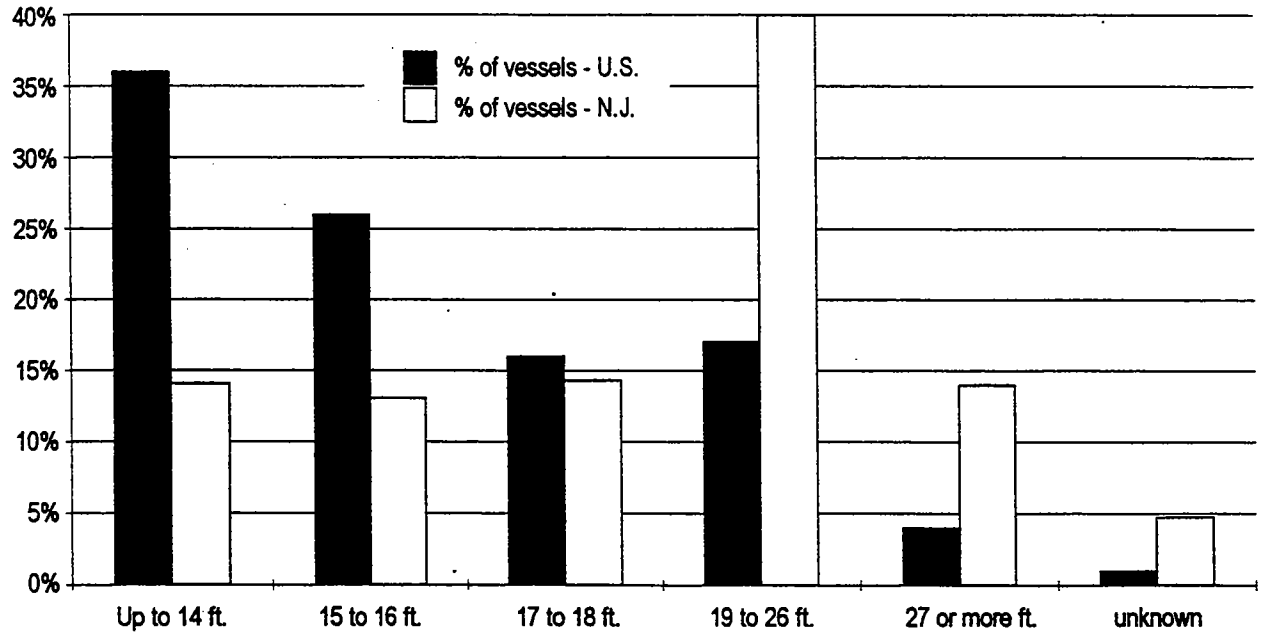
Outboard motor sales for 1989 grouped by horsepower. The "average" size was arrived at by dividing the total horsepower sold by the total number of motors sold.

Fleet composition by type - New Jersey/total U.S.



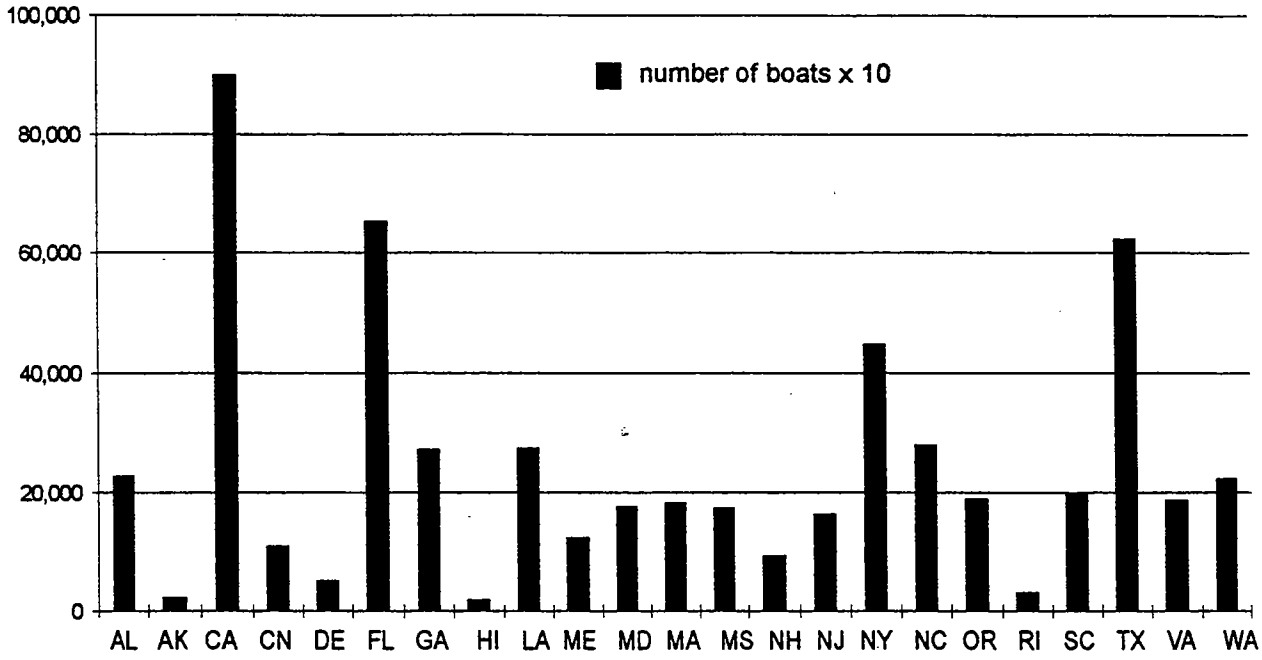
The major variable in the overall character of boating activity in an area seems to relate to coastal (including the Great Lakes)/inland differences. Contrasting the composition of the New Jersey fleet with the national fleet, New Jersey - and I think we can safely assume other states with access to "big" water - has a greater proportion of larger, cabin cruiser types of boats and inland states have a higher proportion of bass boats and rowboats/canoes, vessels that are generally associated with quieter, more sheltered waters.

Vessel distribution by length - New Jersey/total U.S.



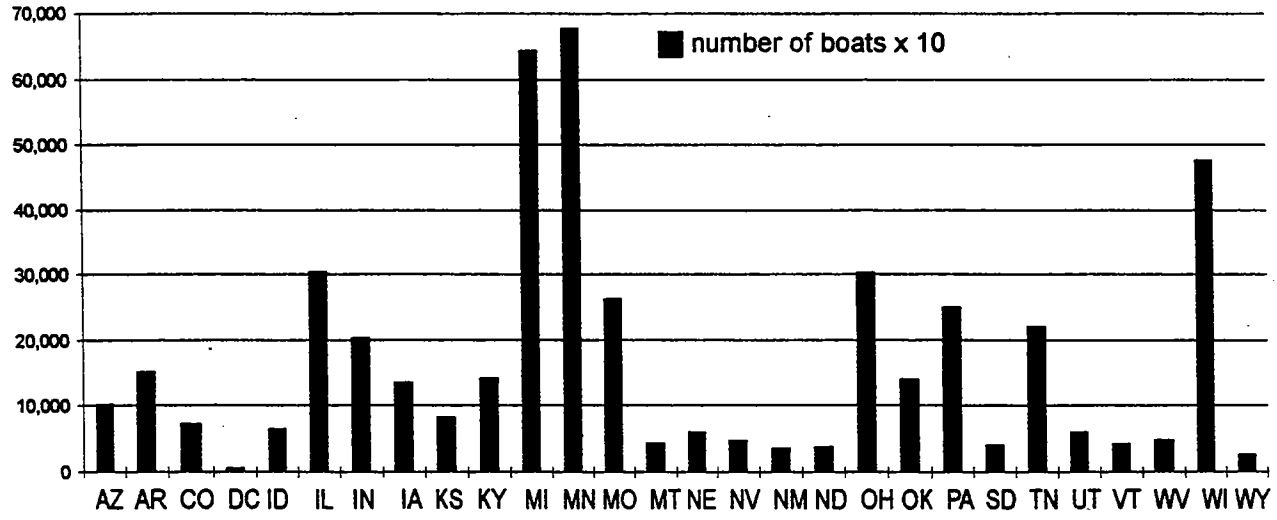
This shows the distribution of vessels grouped by length nationally and, again used as a "typical" coastal state, New Jersey. As would be expected, the distribution is skewed towards larger vessels in the latter and indicates what appears to be the primary difference between inland and coastal - "big" water - boating. It's reasonable to expect that the proportion of larger, more powerful motors is greater in the coastal states as well.

Total vessels Registered - Coastal States



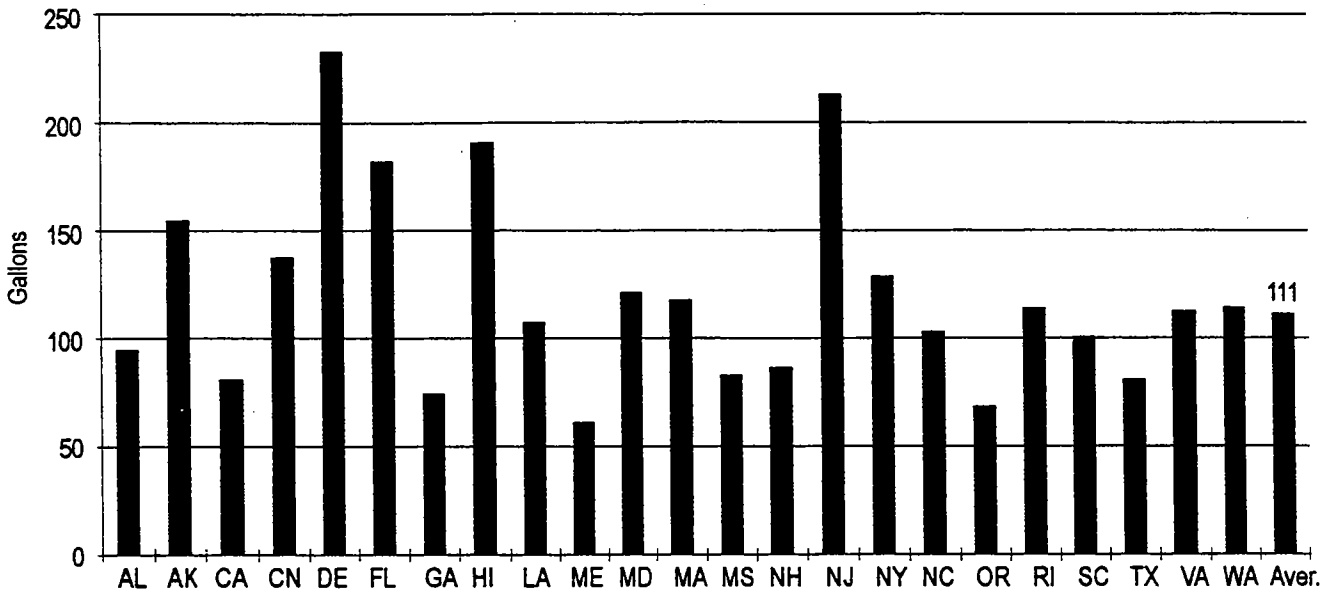
On the coasts recreational vessels seem to be concentrated - not surprisingly - in the states with the longest coastlines or with the easiest access to the coast.

Total vessels registered - Inland States



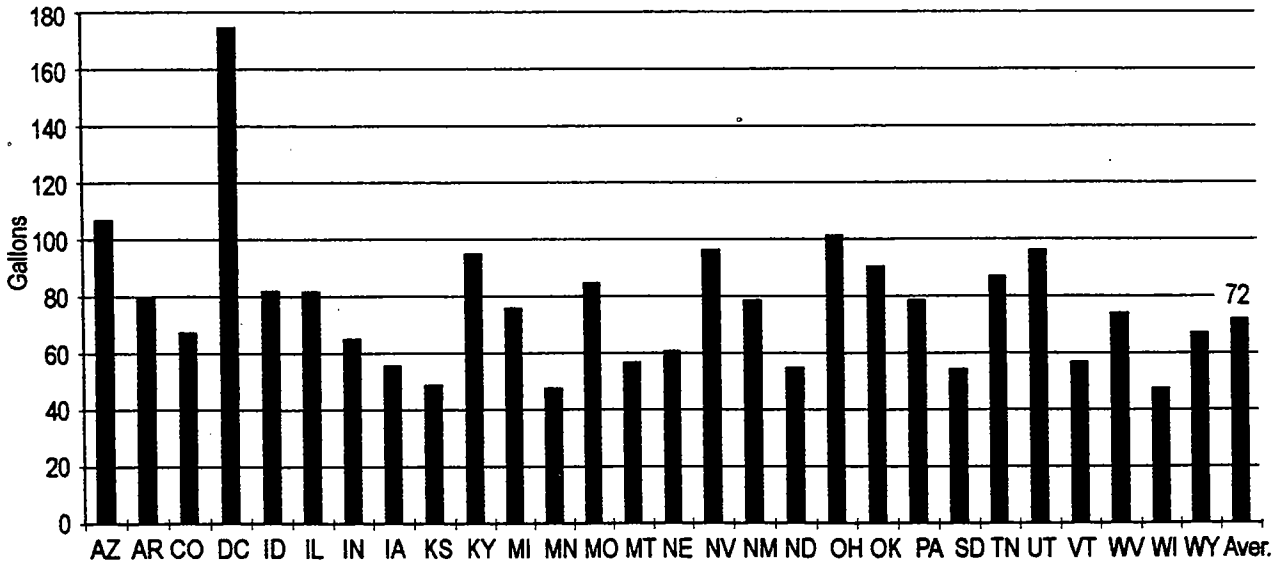
This is the vessel registration for the inland states. There is an obvious concentration in the "lake" states.

Per vessel annual fuel use - Coastal States



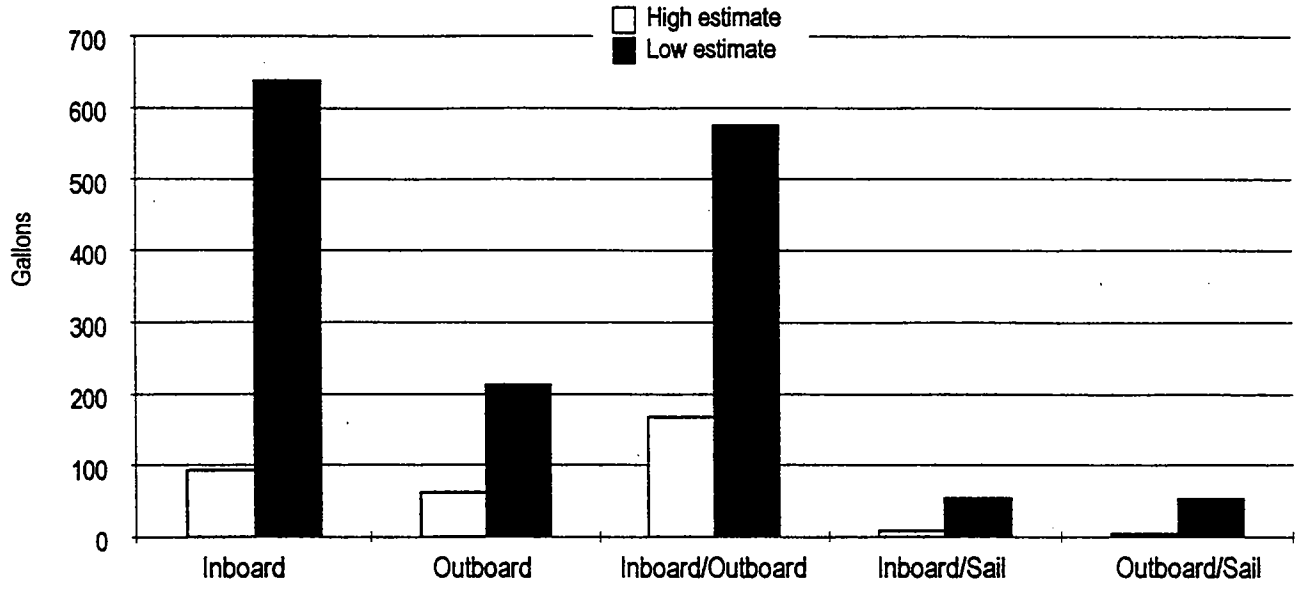
In the coastal states there is quite a bit of variation in average annual fuel use. More significantly, however, compare the 111 gallons per year used in the coastal states to the 72 gallons per year in the inland states. This indicates that either the average engine size, the hours of use or the type of use (or some combination of the three) is different in coastal and inland areas. Considering that the U.S.E.P.A. proposed emissions regulations are based to a certain extent on engine size, this difference might lead to an uneven distribution between the coastal and inland states of the total allowable pollutant loading when the regulations go into effect.

Per vessel annual fuel use - Inland States



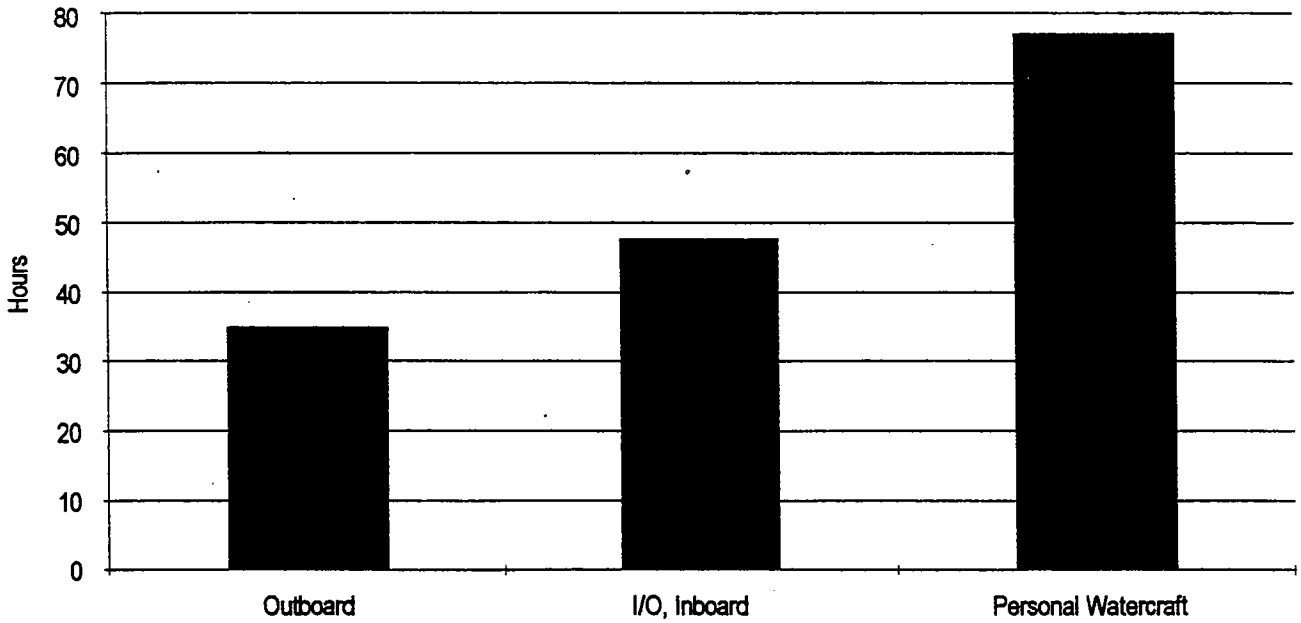
In the inland states, however, the average annual fuel use is fairly uniform (with the very obvious exception of the District of Columbia. This might be a reflection of either larger boats or the necessity to travel farther to reach suitable boating areas). There doesn't seem to be much differentiation between northern and southern states or between those with a lot of boating sites and those with not so many.

Annual fuel use by vessel type



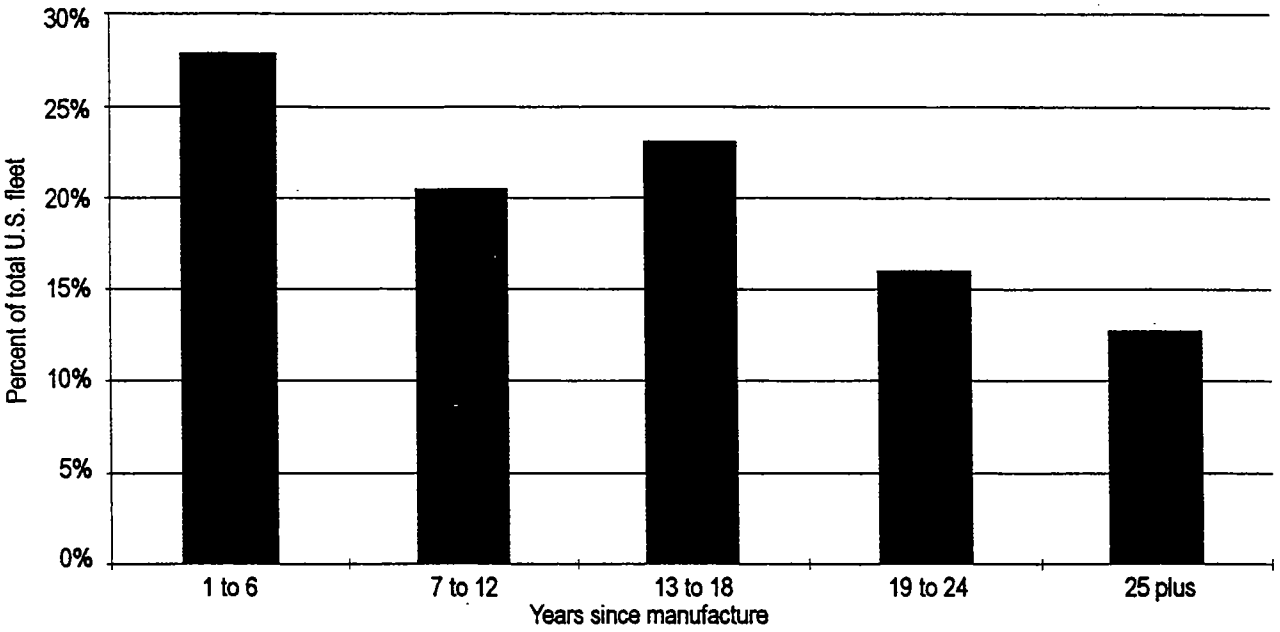
From the U.S.E.P.A. Nonroad Engine Vehicle Emission Study, annual fuel use by vessel type. The difference between the high and low estimates reflects the lack of available hard data that is apparent in virtually every aspect of recreational boating. The largest recreational boats are powered by inboard engines. Because of their larger size, inboard/outboard engines can't be used in the smaller boats, which end up with outboards by default. This difference in vessel size would account for a large part of the fuel use differential.

Average hours of annual use by vessel type - U.S.



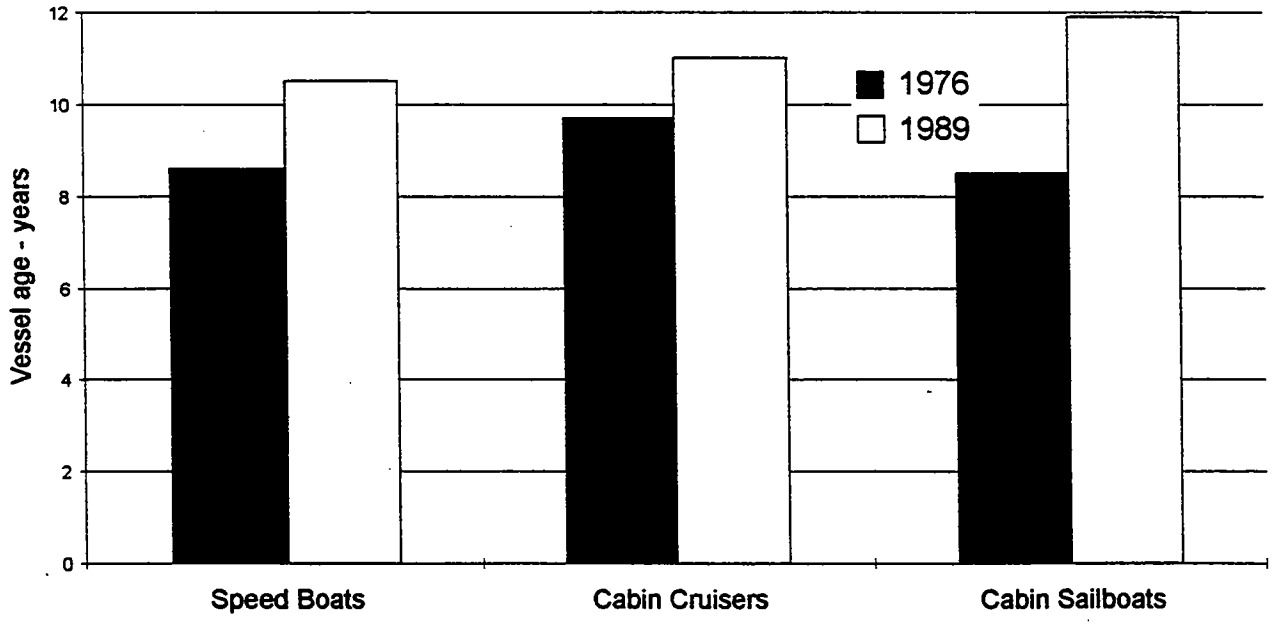
This graph, from U.S.E.P.A. data used to calculate the costs of the proposed marine engine emissions regulations, shows the average annual use of recreational vessels based on the type of propulsion. Of particular interest is the high useage of personal watercraft - particularly when their sales are growing much more rapidly than those of any other type of powered vessel.

Average Vessel Age - total U.S.



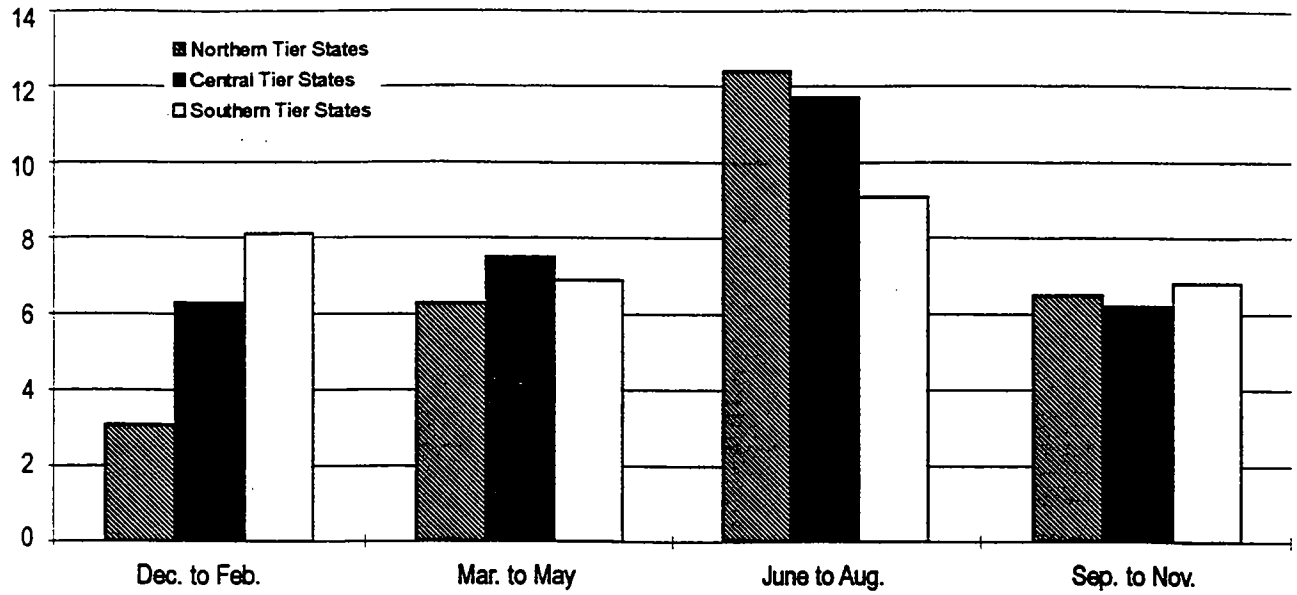
Since fiberglass, which under normal conditions of use is for all intents and purposes indestructible, became the construction material of choice for almost all small boats, the recreational fleet has both aged and expanded. In the proposed Marine Engine Emissions Regulation's Regulatory Impact Analysis, the U.S.E.P.A. assumed a 28 to 54 year life for outboard motors, 40 years for sterndrive and inboard engines and 20 years for personal watercraft engines.

Average vessel age by type - U.S.



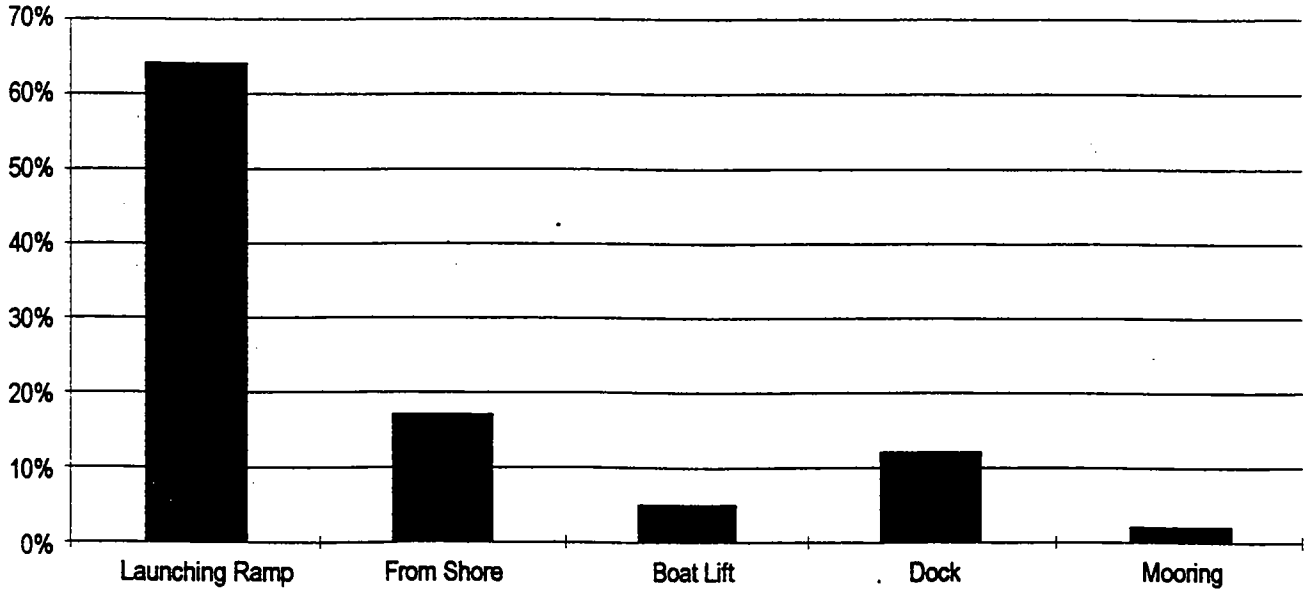
Again from the U.S.E.P.A.'s Regulatory Impact Analysis, this shows a marked increase in the age of the fleet that is probably a reflection of the move to fiberglass (with some possible influence by the prevailing economic conditions). With the resurgence in recreational boat manufacturing over the last several years the average age has probably declined somewhat.

Average number of boating trips per season



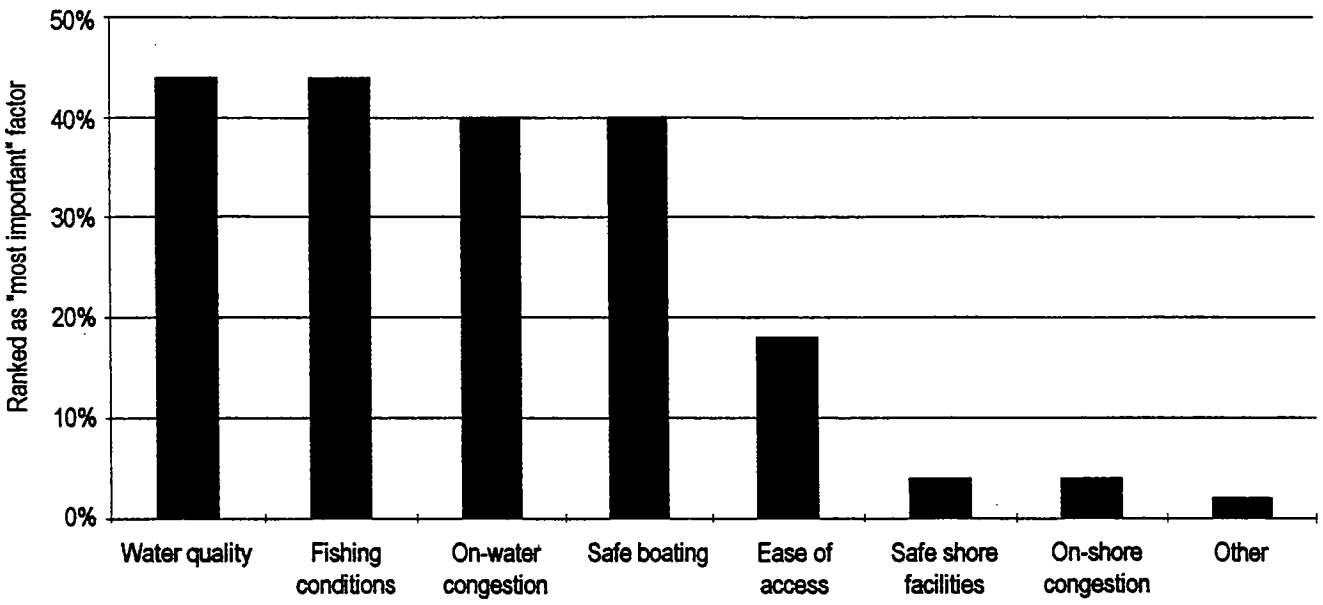
With the exception of an expected minimum in the northern states in the winter, the amount of recreational boating activity reported by the U.S.F.W.S. doesn't vary much from North to South. In the U.S.E.P.A.'s Nonroad Engine and Vehicle Emission Study it was reported that, depending on the region, the summer months accounted for from 48% (West Coast, Southeast, Southwest) to 68 (Northeast) or 70% (Great Lakes) of annual marine equipment use.

Method of vessel launching



In spite of what we observe in our coastal areas, the greatest number of recreational boats do not stay in the water between use but are launched for every trip. This mobility makes tracking recreational vessel use difficult.

Boating quality criteria



Finally, and again this is from the U.S.F.W.S., these are the factors that the recreational boating public consider the most important in determining the quality of a recreational boating experience.

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