

Marina owners need to proactively plan for and implement measures to reduce risk and increase resilience against changing sea levels and other climate factors.

What is a 'Resilient Marina' and Why it Matters

By Daniel Stapleton, Matthew Page and Wayne Cobleigh

Editor's Note: This article is the first in a series of three articles that discuss the objectives, practical implementation and benefits of creating "Resilient Marinas."

Marinas provide boaters with access to the water and wonderful opportunities for recreation and community. However, their waterfront locations place marinas at the forefront of vulnerability and risk to severe weather hazards and climate impacts, including property damage, costs of recovery and reconstruction, disruption of business operations (sometimes up to several years) and increasing business and customer costs. These risks are compounded by the increasing valuation of both marina property and marina vessels and the increasing costs of recovery and reconstruction, all of which contribute to increased financial exposure.

For perspective, from 1980 to 2024, the distribution of more than \$1 billion disaster events in the United States was dominated by hurricanes — a key hazard to coastal marinas located along the Gulf and Atlantic coasts. Total damages from these weather events have averaged about \$23 billion per event, for a total of \$1.5 trillion. Including other severe weather events increases the total to \$2.9 trillion. (Reference NOAA's National Centers for Environmental Information). These losses are unsustainable relative to available federal disaster relief funding, and for public (National Flood Insurance Program) and private insurance carriers. Current private insurance trends, due to increasing risks to primary and reinsurance carriers, include increasing policy costs, higher deductibles. reduced coverage and/or loss of available coverage, including both marina and customer policies. These risks are increasing due to changing sea levels and other climate factors. Similar to other types of residential and commercial real estate that are vulnerable to natural hazards, the solution for marina owners going forward is to proactively plan for and implement measures to reduce risk and increase resilience.

"Resilient Marinas" are marinas that have implemented specific measures to reduce the risks of severe weather and the future effects of climate and to rapidly recover from severe weather events. Consistent with the state Clean Marina certification programs, the Association of Marina Industries (AMI) is considering development of resilience guidance and certification standards for marinas.

Marina Vulnerability

Marinas are vulnerable to the effects of severe weather events, including high winds, intense precipitation, flooding, waves and hail and lightning. The storm types impacting marinas differ by location but typically include tropical storms and hurricanes, extratropical cyclones, which are major weather events in the Great Lakes, the Mid-Atlantic and New England (nor'easters) and single cell to mesoscale thunderstorms.

Tropical storms and hurricanes in the northern hemisphere typically occur between June 1 and November 30, are of short duration and include very high winds, high storm surge, intense precipitation, lightning, hail and tornados or waterspouts. Extratropical cyclones in the Great Lakes and East Coast occur predominantly from November

through March, can be several days in duration and can include relatively high winds, high storm surge and intense precipitation including rain, sleet or snow. Thunderstorm systems occur during the warm season in the northern United States and all year in the southern United States and can include single cell, multicell, supercell, squall lines (e.g., Derechos) and mesoscale convective systems. These storms are of very short duration, except mesoscale systems, which can last for hours and result in high to very high winds, intense precipitation, lightning, hail and tornadoes and waterspouts.

Marina assets and customer vessels are vulnerable to damage during these severe weather events. Damage to these assets occurs due to flood inundation, rain infiltration, exposure to hydrostatic, hydrodynamic, wind and wave loads and occasionally damage due to hail and lightning strikes. Flood inundation due to storm surge, or lake seiches in the Great Lakes, can result in direct damage to building structures, cladding and contents, such as offices and equipment and long-term damage due to salt and water exposure. Building structures, aboveground fuel tanks, shore power components, washdown treatment systems, etc. can also be damaged by wind and wave loads as well as flood inundation. Fixed docks are damaged due to vertical and lateral wave loads. Floating docks are damaged when storm surge and waves result in the docks floating off the guide piles, along with any attached vessels, and by waveinduced displacement of docks and dock connections. Docks are also damaged due to contact with vessels. Vessels are damaged from contact with docks and other vessels, failures of cleats and

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> mooring lines and/or becoming freefloating within the harbor. Damage to fueling stations and submerged vessels can result in environmental releases or fire. Damage to shore power systems can result in fire and risk of electrocution.

> When damage is substantial, marina owners, operators and customers are left with the difficult, long and costly process of recovery, including salvage, demolition, debris management, insurance claims and reconstruction.

A challenge for marina owners, operators and customers is to understand the risks. For professionals in the risk industry, such as FEMA, insurance providers or catastrophe modelers, risk is characterized based on quantifying: 1) the probability and uncertainty that a certain severe weather condition may occur; 2) the damage that would result from that event; and 3) the consequences (e.g., property damage, disruption of operations, etc.) that would result from that damage. Through this risk analysis process, the risk can be quantified using standardized risk metrics. Property risks, including marina assets and customer vessels, are typically determined on an annualized basis. For example, the 1% Annual Exceedance Probability (AEP) event is an event that has, in any given year, a 1 in 100 chance of being experienced or exceeded. Over 25 to 30 years, which is the typical service life of docks, the chance of experiencing or exceeding this event at least once increases to about 26%. This example is used here since the 1% AEP flood is the commonly used FEMA Base Flood shown on FEMA Flood Insurance Rate Maps (FIRMs) and used by the National Flood Insurance Program (NFIP).

Since a severe weather event has a 1% AEP chance of occurring, then

the predicted damages and associated consequences also have about a 1% annual chance of potentially occurring. For example, if marina damages for a 1% AEP severe weather event were predicted to be \$10 million, the "expected" annual losses would be predicted to be about \$100,000 or 1% of \$10 million. When this process is performed over a wide range

of probable events, key information can be developed to characterize risk. For example, damages associated with high probability events as well as low probability events can be considered and planned for. Financial risk metrics include the Expected Annual Damage (EAD) and the Average Annualized Loss (AAL), which indicate what the "average" costs are likely to be on an annualized basis over long periods of time. This is a method used to establish insurance risks and policy premiums.

Future changes to the climate may have the effect of increasing these annual risks over time due to increasing the frequency and/or intensity of severe weather events and factors such as sea level rise. Climate effects can also have long-term sustainability, structure service life and ecological challenges for marinas including "sunny day" flooding, increasing air and water temperature, changes to water chemistry (e.g., acidity), etc.

Using these risk metrics, the benefit-

cost ratio (BCR) of implementing resilience measures can also be developed with the goal of investing in property improvements with a BCR exceeding a value of 1.0 and preferably 4 or higher, meaning \$4 or more in avoided losses for every \$1 invested.

Characteristics of a Resilient Marina

A "Resilient Marina" is a marina that has implemented measures to cost-effectively reduce the vulnerabilities, damages and negative consequences of severe weather events and the potential long-term adverse effects of climate. Remaining insurable at reasonable cost is also important. While marina owners, operators and customers cannot change the probability of a severe

weather event occurring, they can prevent or reduce the associated damages and consequences and ensure rapid recovery. These are the basic goals of a "Resilient Marina."

Resilience, or risk reduction, measures typically fall into four categories. The first two risk reduction categories are property improvements, including the design and construction of resilient and fortified structures, systems and utilities, and operational measures, such as Severe Weather Preparation Plans, that reduce damages during a severe weather event by planning and preparation. The risks that remain after implementation of these two categories are considered "residual risks" that are typically covered by insurance - the third category of resilience measures. The fourth category of resilience measures is "recovery," which includes proactive measures for timely and successful insurance claims, vessel salvage, debris management and reconstruction. Keep in mind that the recovery of a marina will take place while the community or state is also trying to recover, limiting access to available recovery resources.

Why It Matters

The goal of "Resilient Marinas" is relevant to all interested stakeholders, including owners, operators, investors, customers and even the communities in which the marinas are located.

Many marinas may currently be underinsured relative to their actual risk; underinsured marinas may never recover should a substantial severe weather event occur.

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> Even when insured, marina owners may expend all their financial resources (insurance, loans, savings, etc.) to recover from one event only to experience another devastating severe weather event a few years later.

Investment in new construction, replacement of docks, etc. without considering these risks can result in under-design and poor performance that will be costly over the service lives of these improvements, requiring premature replacement. Conversely, designing strengthened and fortified structures for resilience will, based on experience, have a 4 or greater BCR due to prevented losses to both the marina owners and customers.

Severe weather and climate risk can result in a long-term reduction of marina property values. Conversely, property values can be maintained or increased though investment in resilience measures.

Excessive severe weather risks of vessel damage, loss and/or liability at the vessel "home port" can result in increased cost of insurance or even loss of insurance for the vessel owner. Conversely, providing a resilient and storm-resistant facility will increase desirability for existing and potential customers.

While the industry has recently experienced growth, consolidation and new development investment, the risks of severe weather and climate-related losses and the adverse effects on the insurance industry will increasingly present significant industry "headwinds," which will affect both marina owners as well as customers. Reducing these risks

by investing in and creating resilience will go a long way to preventing these negative outcomes.

In Conclusion

Creating "Resilient Marinas" will sustain the industry, maintain the availability of affordable insurance, reduce costs, reduce liability, attract new customers and improve marina owner profitability.

It will also create new financial opportunities for marina owners. make a safer environment for marina employees and customers and improve the marina experience. Implementing resilience measures can be done costeffectively when well-planned and incorporated into the marina's broader goals and development plans. It starts with establishing a clear understanding of what the vulnerability and risks are and then implementing prudent and feasible risk reduction measures, including designing and constructing resilient structures and systems, severe weather planning and preparation, "residual risk" management and timely recovery. 🗘

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