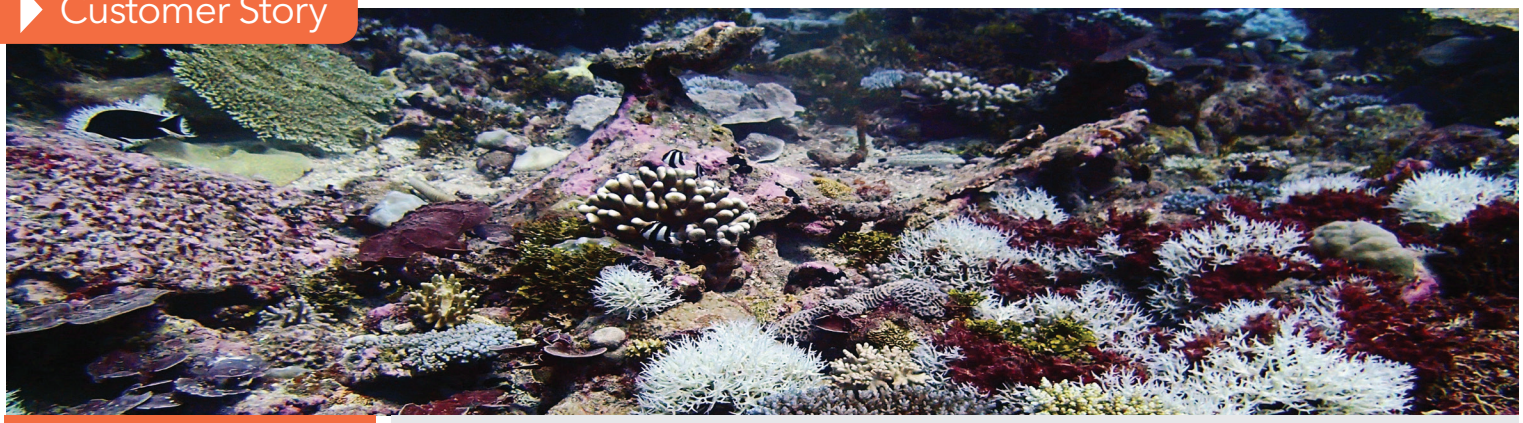
Customer Story



KHALED BIN SULTAN LIVING OCEANS FOUNDATION

Challenge

With the rapid advance of climate change, coral reef health is in decline globally. Scientists are working against the clock to optimize reef preservation efforts and prevent further degradation and bleaching.

Big data and the race to save coral reefs

With climate change fast eliciting coral bleaching on global scales, marine biologists are using predictive modeling to help prioritize conservation efforts.

Though coral reefs constitute less than 2% of the Earth's oceans, they play a critical part in ocean health and are among the most diverse ecosystems on the planet. Not only are they home to scores of marine species, but their immense impact extends to local economies, supporting fisheries, encouraging tourism and protecting shorelines from erosion – an impact valued at billions of dollars each year. With an outsized role in both environmental and economic success, protecting these fragile reefs should be a global priority, yet coral reef health around the world continues to decline. Climate change, in particular, has accelerated the degradation of reefs, and scientists now estimate that more than half of the world's coral reefs have been lost over the past four decades due to climate change and other human-associated factors. Although scientists broadly understand the causes of coral reef bleaching and (later) death, predicting specifically which reefs are most at risk, which are most resilient, and which should be prioritized for conservation continues to be among the field's foremost challenges.

Organizations like the Khaled bin Sultan Living Oceans Foundation seek answers to these questions, and marine scientists the world over are investing in international coral reef research, conservation and restoration efforts. With their support, Dr. Anderson Mayfield, PhD, has devoted his career to the study of reef coral physiology, arguing that scientists need a more rigorous, statistically driven approach if they are to understand – and mitigate – the breakdown of corals in response to environmental shifts before it is too late.

Boosting the statistical power of scientific conclusions

With the immediacy of the threat now facing coral reef ecosystems around the world, Dr. Mayfield – an assistant scientist at the National Oceanic and Atmospheric Administration's Atlantic Oceanographic and Meteorological Laboratory in Miami – believes there is a need to be more proactive about marine science, and especially marine conservation efforts. That's why he and his collaborators are making the case for a statistical approach. Predictive modeling, he says, can help to determine which reefs are more susceptible to environmental stress – and which are most resilient – thereby enabling conservation funding agencies to prioritize targeted mitigation efforts.

"Some corals will bleach regardless," Dr. Mayfield explains. "But there are other reefs where if we alleviate some of the local pressures, they're going to be more likely to survive." Although it's difficult to decide which reefs are most worth protecting, some have shown high resiliency in the face of increasing environmental pressures. Identifying critical survival factors may allow researchers like Dr. Mayfield to better predict which reefs are more prone to stress and thwart future bleaching elsewhere.

Dr. Mayfield's statistical models represent a significant departure from his previous reliance on experimentation with coral conspecifics grown in laboratory tanks, where he says results were not sufficiently statistically powerful to account for natural species variation. By contrast, big data statistical modeling is enabling him to make use of worldwide data surveys that are both deeper and more geographically expansive than data amassed by any individual scientist.

In recent papers published in Platax (2018) and Journal of Sea Research (2019), Dr. Mayfield and his co-authors looked at data sets from understudied regions of the South Pacific using a combination of univariate and multivariate methods. Critically, the researchers explored 12 environmental factors (e.g., temperature, reef structure, fish biomass) expected to influence coral physiology. Best-fit models produced by stepwise regression and partial least squares showed that only a subset of such routinely assessed environmental parameters were needed to explain a significant portion of the variation in physiological response.

We might already have all the data we need to address certain coral reef issues, but we just aren't analyzing them the right way.

Anderson Mayfield, PhD

Robust predictive modeling with JMP®

When Dr. Mayfield first began his training in marine biology, he was far from the outspoken proponent of statistical methods he is today. Having not yet been exposed to formal multivariate statistics in any real way – and because the variables in the tank experiments of his early career were largely known and tightly controlled – Mayfield jokes that his analysis was limited to what could be done on a graphing calculator. This had to change, however, as his research expanded into more field-based projects for which a new level of statistical sophistication was necessary. Fortunately, it was around that time that Mayfield also got started with JMP statistical discovery software. Now he won't use anything else.

With JMP, Dr. Mayfield says, "even with the same amount of data, the amount [of information] it tells us has expanded exponentially." Bringing the statistics in-house also limits his reliance on external statistical resources, which inevitably add more time to the research process. And time is a precious resource in light of the growing crisis of coral bleaching. "We don't really have the luxury to sit around for five years and think about how to analyze the data," he explains. "We may not be able to predict with 100% certainty whether a coral is going to die, but if we have enough data already about how corals behaved in the past ... we might say based on our past data that a one-degree [seawater] temperature increase results in a 30 percent change in coral growth."

Though it is still a nascent idea, Dr. Mayfield is excited to explore the opportunities big data affords in the field of reef coral physiology. With new models developed in JMP, he can test their predictive power with an extensive field data set. "We won't know until we test [a model]," he says, but luckily, JMP has built-in platforms that support this type of model accuracy testing; when you build your models, JMP will tell you whether your model worked for each sample. "JMP's predictive modeling platforms already have the pieces of the puzzle in place, they're just waiting for this kind of data to come so that we can play around with it."

Accelerating research through data transparency

As Dr. Mayfield is painfully aware, copious data languish unused by researchers who lack either the time or statistical knowledge to analyze them. Moreover, given the pressure to publish and competition between scientists, most are reluctant to share their data (even data they have already used in published works). With such a time-sensitive problem like coral reef bleaching, though, data sharing could be a key factor in accelerating the state of the science and determining the most effective conservation strategies. "Especially in our field, [scientists] should be more open about how they analyze the data and make real efforts to get it out there. It's not doing any good just sitting on a computer," he says.

And Dr. Mayfield leads by example – JMP gives him the tools for promoting transparency in his own research, such as interactive HTML features that allow for real-time data analyses. "JMP has given me so many ideas – new ways of making my data more interactive and not just in terms of visualization but showing people the thought process behind how I analyzed it," he says. Dr. Mayfield now uses JMP Public as a means of disseminating dynamic visualizations. Data filtering capacity in JMP Public, he says, will allow collaborators to quickly identify samples they may wish to analyze in more detail.

Dr. Mayfield hopes that by disclosing the details of his own research, and by boosting the reproducibility of his methods, he can encourage colleagues toward similar transparency, bringing the field together in pursuit of tangible solutions to coral reef decline. "We might already have all the data we need to address certain coral reef issues," says Dr. Mayfield. "We just aren't analyzing them the right way." JMP could change that. And now, Dr. Mayfield's research is only limited by the questions he asks.

Solution

By increasing the level of statistical sophistication in their research, marine biologists can draw more substantive conclusions from coral reef data sets. JMP makes robust statistical modeling less daunting for non-statisticians.

Results

Through enhanced collaboration and data transparency, scientists are closer to developing new approaches aimed at best driving future coral reef conservation efforts.

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