

## SUMMARY

In this project, researchers developed alternative feeds for two high-value marine finfish species, California yellowtail (popular on sushi menus) and white seabass.

The new feeds are of significance, as they contain little to no fishmeal, fish protein being successfully replaced with a mix of high-quality poultry by-products, concentrated corn protein, Spirulina and chicken liver meal (for palatability).

According to the scientists leading this project, the new diets do not compromise fish growth, survival or feed conversion rates. Findings underscore the potential to rear marine finfish without depleting wild forage species for fishmeal.

## PROJECT

In the project's first year, researchers identified an appropriate mix of alternative protein sources from candidates such as soy, corn, barley, Spirulina, poultry-by-product meal and blood meal. This work showed that a mix of chicken meal, Spirulina and corn could be used as a substi-

tute for fishmeal. In a series of experiments, they progressively lowered the fishmeal content in the species' diets, replacing it with the new protein mix, while monitoring fish health.

The fish for the experiments were offspring of broodstock

kept at the Hubbs-SeaWorld Research Institute's aquaculture facility in Carlsbad. These species were selected for the study as both are top candidates for commercial culture.

Currently, the institute rears white seabass for stock enhancement

and is leading a pilot project to propagate yellowtail in net pens in Baja California, Mexico.

These projects are establishing the husbandry techniques needed for developing a North American aquaculture industry that can compete with overseas operations.



Fish nutritionist Rick Barrows examines flax oil that will be infused into pellets for feed for rainbow trout, part of another project. Image: Stephen Ausmus for USDA



Various types of prepared fish food. Some may look familiar to aquarists. Image: Pinpin/Wikipedia Commons

## RESULTS

Based on the experiments, white seabass can be raised on a diet free of fishmeal without compromising fish growth or feed conversion rates; yellowtail were shown to thrive on diets containing between 10 percent and 20 percent fishmeal. Their standard feed contains about 30 percent fishmeal, by weight.

Promisingly, in a commercial-scale trial, the fishmeal-free white seabass grew faster and boasted improved feed conversion rates, as compared with their counterparts on "store-bought" pellets. Diets

that contained 30 percent Spirulina were especially promising in terms of their ability to improve growth and feed conversion. Experiments with yellowtail indicate a similar beneficial response from the algae, which are rich in minerals and have a higher percent protein content than beef.

The next step of the project – one that is proving difficult – is to find replacements for fish oil, such as soy, canola oil and poultry fat, to further reduce industry's reliance on wild species.



## OUTREACH

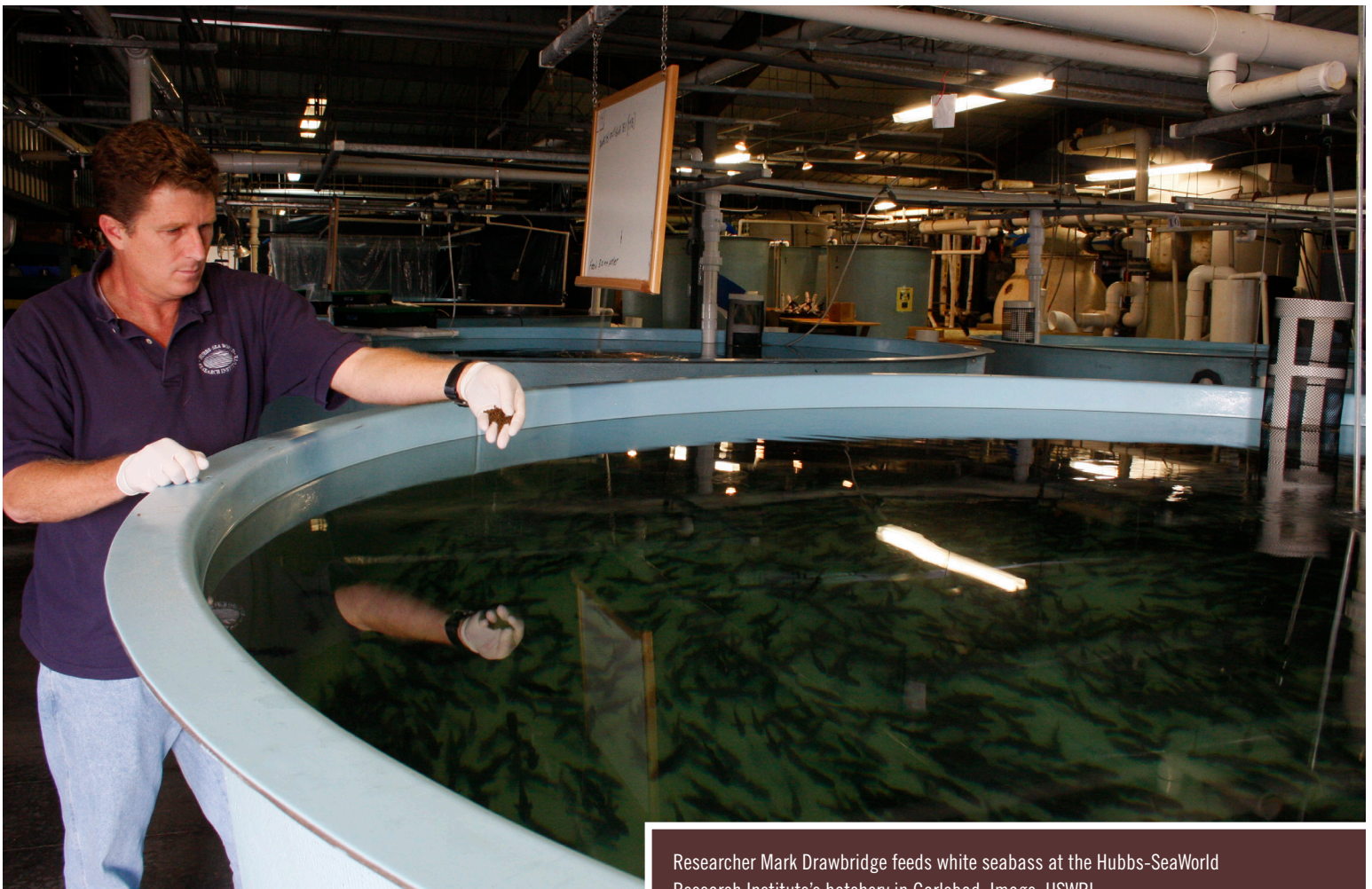
Based on their results, researchers produced a comprehensive “menu” of feed ingredients and ingredient combinations, with their associated effects on fish growth and fish condition. The information makes it possible for fish farmers and commercial feed producers to adapt what they feed their fish or how they produce feed, as costs of various ingredients change.

Results from this project were presented at the 2010 meeting of the World Aquaculture Society in San Diego and discussed in an article in *SeaFood Business*. The lead scientist also held a special fish nutrition workshop during the conference dedicated to finfish species in Southern California and Baja California, Mexico.

## IMPACTS

This project directly supports NOAA/USDA Alternative Feeds Initiative to accelerate the development of fish feeds that use less fishmeal and fish oil, without compromising the health benefits (e.g., the omega-3 fatty acid content) of farmed seafood. Results have been shared with NOAA’s Aquaculture Program.

About half the cost of rearing fish can be attributed to the price of feed. With a limited wild supply of forage fishes and a growing appetite for seafood, the cost of fishmeal, and hence the cost of farmed fish, is expected to keep climbing. By developing new feeds, aquaculture can become both more economically and environmentally sustainable.



Researcher Mark Drawbridge feeds white seabass at the Hubbs-SeaWorld Research Institute’s hatchery in Carlsbad. Image: HSWRI

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