

## A Message from Don Kent, President/CEO

Our nation, if not the world, has felt the challenges resulting from the slow recovery of the global economy. But, just like in nature, *what doesn't kill you makes you stronger*, and the Institute is no exception to that rule. Despite the condition of the economy, we have worked hard to continue to provide *Sea Life Solutions* to the problems facing our oceans.

We continue to develop innovative ways of studying the world's wildlife toward conserving them for future generations. We are now using new remote-controlled drones to survey marine mammal and bird populations and to find fish in the open ocean. Our scientists continue to develop new diets for farmed fish that do not rely upon fish meal as their primary source of protein and oil. We continue to respond to strandings of wild dolphins and other mammals to better understand how human activities are impacting the world's wildlife. How we balance the economic and social necessity of working in the natural world against its aesthetic and ecological value is at the core of the Institute's mission.

As we prepare to celebrate the Hubbs-SeaWorld Research Institute's (HSWRI) 50<sup>th</sup> anniversary in 2013, I reflect back on the first half century of our existence and the ever growing importance of the role we play. In 1963, the year the Institute was founded, the world population was about 3.1 billion and San Diego was the *fishing capital of the world*. In 2012 the population grew to more than 7.5 billion and our nation imported over 90% of its seafood. With over 70% of the world's population living along the coast, the impact of a burgeoning population will be most keenly felt in our oceans. What will happen within the next 50 years when the global population exceeds 9.7 billion? The Institute has dedicated its first fifty years to solving the problems we face now toward ensuring that our children and their children aren't faced with even greater problems.

In 2013, we look forward to highlighting Institute milestones from the first half century and celebrating the contributions of our faithful friends and supporters. We invite you to join us by renewing your commitment to Hubbs-SeaWorld Research Institute.

## Selected Program-Specific Highlights from 2012

### AQUACULTURE

Researchers at HSWRI began participating in a new multi-institution collaborative project this year focusing on improving larval nutrition for marine finfish species through optimizing feed types, composition, and delivery methods. Weaning juvenile fish from a live-food diet to a pelleted food is one of the largest challenges facing marine aquaculture. HSWRI is making progress in identifying an appropriate live-feeds weaning regime for two commercially and recreationally important species, white seabass and California yellowtail. A related study is focused on incorporating plant-based protein into fish diets. Early results are promising – the fish are eating the diets and growing. Based on these early successes, the feeding trials are expanding from a few weeks to many months to ensure the diets' suitability throughout the growout process.



Shellfish research to determine genetic stock structure of green abalone, listed as a Species of Concern by NOAA Fisheries

The aquaculture program branched out into shellfish research in 2012 with a study to determine the genetic stock structure of green abalone. Green abalone is listed as a Species of Concern by *(continued)*

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the National Oceanic and Atmospheric Administration (NOAA) Fisheries and is being considered as a candidate for stock replenishment in southern California.

Interest by anglers' groups, private entities and the state in replenishing California halibut continued to grow. A genetic management plan for broodstock and production cohorts was drafted and new brood fish have been introduced into HSWRI's existing breeding population.

Expansion of the HSWRI aquaculture program in Florida in 2012 was slow, but steady. Discussions continued with local, state and federal partners regarding a HSWRI-designed and operated fish replenishment hatchery.

## **BIOACOUSTICS**

The HSWRI Bioacoustics Program continued its focus on research projects involving SeaWorld's animal collection. Several graduate students from the University of San Diego and the University of Washington are involved with the program and are making important contributions to the field. Research topics include:

- Vocal learning in killer whales including several projects providing evidence for a 'sensitive period'
- Differences in the timing and acoustic features of killer whale calls in matching exchanges related to positive and negative responses from a social partner
- New tools for processing killer whale calls including techniques for identifying individuals reliably

The laboratory has developed a system for visualizing killer whale calls in the same frame as digital video of behavior, allowing a detailed analysis of the interactions between social behavior and sound production.

## **ECOLOGY**

Long-term, integrated studies of marine mammals and the habitats they depend upon continued in 2012. Ecological research on marine vertebrates in coastal and offshore regions around the world ranged from 'backyard' studies of bottlenose dolphins in east central Florida and seals and sea lions off the coast of California, to studies of the whale shark - the largest fish in the world - in ocean basins around the world.

Field work on dolphins in the Indian River Lagoon, Florida, continued in 2012 with collaborative photo-identification surveys to document the residence and movement patterns of bottlenose dolphins in the Intracoastal waterways.

The HSWRI Life History Laboratory partnered with other marine mammal stranding network members, NOAA Fisheries, and Duke University on an investigation of the impact of by-catch on populations of white-sided dolphins and harbor



Visualizing killer whale calls in the same frame as digital video of behavior



Field work on bottlenose dolphins in the Indian River Lagoon to document residency and movement patterns

porpoises. The HSWRI team processed and examined over 600 teeth from dolphins and porpoises providing age estimates of animals that had stranded along the Atlantic coast or been incidentally caught in fishing nets.

The Institute's whale shark research program continues to expand. Field expeditions to the Philippines, Western Australia, the Maldives, and West Papua took place within the last 12 months, and scientists worked closely with local educators and others to communicate findings to stakeholders. New and much less expensive tracking devices were tested in 2012 as a way of increasing the number of animals that can be studied. The results from these studies are being used by local conservation organizations and resource management agencies to establish guidelines for marine protected areas and for activities such as eco-tourism.



Study of elephant seals as potential hosts or vectors of avian influenza virus

## PHYSIOLOGY/OCEAN HEALTH

The HSWRI marine mammal stranding rescue and research team responded to dozens of whale and dolphin strandings in east central Florida in 2012 including bottlenose dolphins, a humpback whale, a Risso's dolphin, pygmy sperm whales and pilot whales. The team was called in to assist outside its usual response area to lead the necropsy of a juvenile humpback whale and to assist with a mass stranding of pilot whales in Fort Pierce, Florida. Additional accomplishments included disentangling several animals (including two bottlenose dolphin calves) from marine debris.

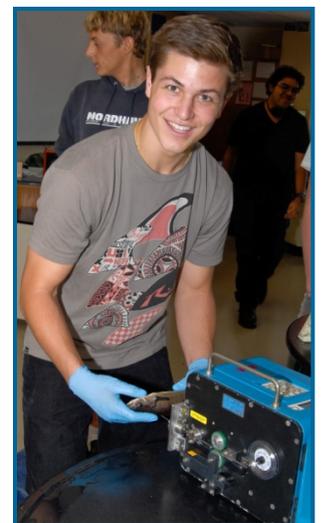
Scientists at HSWRI partnered with colleagues at the Wildlife Health Center, University of California-Davis, on a study of elephant seals as potential hosts or vectors of avian influenza virus in 2011. Hundreds of elephant seals and seabirds are being screened for several subtypes of the virus as part of an international wildlife surveillance program for influenza.

The Center for Marine Veterinary Virology (CMVV) continued to focus on analysis and writing in 2012 with approximately a dozen papers published, in press or in review, on marine mammal viruses and their significance to individual animals and population health.

## STEM EDUCATION AND PEER-BASED LEARNING

In an expanding partnership called Seabass in the Classroom (SITC), HSWRI continued to work with another California-based non-profit organization (Get Inspired!, Inc.) to teach students at Huntington Beach High School and La Jolla High School to grow white seabass as part of the science curriculum. Students are involved in all aspects of caring for the fish from making seawater to feeding. The fish are an official component of the HSWRI white seabass mariculture program and, as such, they are tagged and given a health inspection by state fish pathologists prior to being released into coastal waters. The program will be expanded to additional schools in 2013.

Collaborative peer-based observations and public outreach efforts are being used to enhance our understanding of negative interactions between dolphins and fishers in Florida, with the goal of reducing depredation of fishing gear and accidental entanglements of dolphins.



SITC program student tags white seabass

Education and outreach initiatives (including internships, workshops, lectures, ocean-themed curricula) have been developed with the SeaWorld Education Department, university collaborators, other science partners (e.g., San Diego Natural History Museum, San Diego Zoological Society, National Science Foundation, NOAA SeaGrant) and K-12 partners (individual teachers, schools and districts in California and Florida).

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## Selected Peer-Reviewed Publications 2011-2012

Bengtson, J.L., J.L. Laake, P.L. Boveng, M.F. Cameron, M. B. Hanson and **B.S. Stewart**. 2011. Distribution, density, and abundance of pack-ice seals in the Amundsen and Ross Seas, Antarctica. *Deep-Sea Res II* 58:1261-1276.

Blight, L. K., D. G. Ainley, S. F. Ackley, G. Ballard, T. Ballerini, R. L. Brownell, Jr., C. -H. C. Cheng, M. Chiantore, D. Costa, M. C. Couler, P. Dayton, A. L. Devries, R. Dunbar, S. Earle, J. T. Eastman, s. D. Emslie, C. W. Evans, R. A. Garrott, S. Kim, G. Kooyman, A. Ilescoel, M. Lizotte, M. massaro, S. Olmastroni, P. J. Ponganis, J. Russell, D. B. Siniff, W. O. Smith, Jr., **B. S. Stewart**, I. Stirling, J. Willis, P. Wilson, E. J. Woehler. 2011. Fishing for data in the Ross Sea. *Science* 220:1316.

**Bowles, A.E.** and R.C. Anderson. 2012. Behavioral responses and habituation of pinnipeds and small cetaceans to novel objects and simulated fishing gear with and without a pinger. *Aquat Mamm* 38:161-188.

Curtis, C., **B. S. Stewart**, S. A. Karl. 2011. Genetically effective population sizes of Antarctic seals estimated from maternally, paternally, and biparentally inherited genes. *Cons Gen* 12:1435-1446.

**Durden, W.N.**, E.D. Stolen and **M.K. Stolen**. 2011. Abundance, distribution and group composition of the Indian River Lagoon bottlenose dolphin, *Tursiops truncatus*, using an aerial survey. *Aquat Mamm* 37:175-186.

Fodrie, F.J., B.J. Becker, L.A. Levin, **K. Gruenthal**, and P. McMillan. 2011. Connectivity clues from short-term variability in settlement and geochemical tags of mytilid mussels. *J Sea Res* 65:141-150.

Galaviz, M.A., A. Garcia-Gasca, **M. Drawbridge**, C.A. Ivarez-Gonales, L.M. Lopez. 2011. Ontogeny of the digestive tract and enzymatic activity in white seabass, *Atractoscion nobilis*, larvae. *Aquaculture* 318:162-168.

**Gruenthal, K.M.**, and **M.A. Drawbridge**. 2012. Toward responsible stock enhancement: broadcast spawning dynamics and adaptive genetic management in white seabass aquaculture. *Evol Appl* 5:405-417.

Hayward, L.S., **A. Bowles**, J.C. Ha and S.K. Wasser. 2011. Impacts of acute and long-term vehicle exposure on physiology and reproductive success of the northern spotted owl. *Ecosphere* 2(6), Article 65:1-20. (On-line journal of the Ecological Society of America)

**Jirsa, D.**, A. Davis, **K. Stuart** and **M. Drawbridge**. 2011. Development of a practical soy-based diet for California yellowtail, *Seriola lalandi*. *Aqua Nutr* 17:e869-e874.

**Jirsa, D.**, D.-F. Deng, D.A. Davis, S. Hung, and **M. Drawbridge**. 2012. The effects of dietary lipid level on heat-shock proteins in white seabass (*Atractoscion nobilis*). *Aqua Nutr*. DOI: 10.1111/j.1365-2095.2012.00965.x.

Kastner, R., A. Lin, C. Schurgers, J. Jaffe, P. Franks and **B.S. Stewart**. In Press. Sensor platforms for multimodal underwater monitoring.

McFee, W.E., J.H. Schwacke, L.H. Schwacke, **M.K. Stolen**, K.D. Mullin. 2010. Investigation of growth phases for bottlenose dolphins using a Bayesian modeling approach. *Mar Mamm Sci* 26:67-85.

Owen, M.A. and **A.E. Bowles**. In press. Auditory psychophysics and the management of a threatened large carnivore, the polar bear (*Ursus maritimus*). *Int J Comp Psych*.

Quinley, N, J.A.K. Mazet, **R. Rivera**, T.L. Schmitt, C. Dold, J. McBain, V. Fritsch and **P.K. Yochem**. In Press. Serologic response of harbor seals (*Phoca vitulina*) to vaccination with a recombinant canine distemper vaccine. *J Wildl Dis*.

**Rivera, R.**, R. Robles-Sikisaka, E.M. Hoffman, B.A. Stacy, E.D. Jensen, **H.H. Nollens** and J.F.X. Wellehan, Jr. In Press. Characterization of a novel papillomavirus species (ZcPV1) from two California sea lions (*Zalophus californianus*). *Vet Micro*.

**Rotman, F.J.**, M. Riche, P. Van Wyk, and D.D. Benetti. 2011. Efficacy of a commercial probiotic relative to oxytetracycline as gram-negative bacterial control agents in a rotifer (*Brachionus plicatilis*) batch culture. *North Am J Aqua* 73:343-349.

Schlundt, C.E., R.L. Dear, D.S. Houser, **A.E. Bowles**, T. Reidarson, J.J. Finneran. 2011. Auditory evoked potentials in two short-finned pilot whales (*Globicephala macrorhynchus*). *J Acoust Soc Am* 129: 1111-1116.

**Smiley, J.E.**, **M.A. Drawbridge**, M.S. Okihiro, and R.S. Kaufmann. 2011. Acute effects of gas supersaturation on juvenile cultured white seabass (*Atractoscion nobilis*). *Trans Am Fish Soc* 140:1269-1276.

**Smiley, J.**, M. Okihiro, **M. Drawbridge**, and R. Kaufmann. 2012. Pathology of ocular lesions associated with gas supersaturation in white seabass (*Atractoscion nobilis*). *J Aquat Anim Health* 24:1-10.

Southwell, C., J. Bengtson, M. Bester, A. S. Blix, H. Bornemann, P. Boveng, M. Cameron, J. Forcada, J. Laake, E. Nordoy, J. Plotz, T. Rogers, D. Southwell, **B. S. Stewart**, P. Trathan. In press. A review of data on abundance, trends in abundance, habitat use and diet of ice-breeding seals in the Southern Ocean. *CCAMLR Science*.

Stavros, H.W., **M. Stolen**, **W. Noke Durden**, W. Mcfee, G.D. Bossart and P.A. Fair. 2011. Comparison and correlation of trace elements in tissues from stranded and free-ranging bottlenose dolphins (*Tursiops truncatus*) from the U.S. southeastern Atlantic coast. *Chemosphere* 82:1649-1661.

**Stolen, M.**, **W. Noke Durden**, **T. Mazza**, N. Barros, and J. St. Leger. In Press. Effects of fishing gear on bottlenose dolphins (*Tursiops truncatus*) in the Indian River Lagoon system, Florida. *Mar Mamm Sci*.

**Stuart, K.** and **M. Drawbridge**. 2011. The effect of light intensity and green water on survival and growth of cultured larval California yellowtail (*Seriola lalandi*). *Aquaculture* 321:152-156.

**Stuart, K.**, and **M. Drawbridge**. 2012. Captive spawning and larval rearing of California yellowtail (*Seriola lalandi*). *Aqua Res* doi:10.1111/j.1365-2109.2011.03077.x.

**Stuart, K.**, and **M. Drawbridge**. 2012. Spawning and larval rearing of yellowtail amberjack (*Seriola lalandi*) in Southern California. *Bull Fish Res Agen* 35:15-21.

**Stuart, K.**, and **M. Drawbridge**. 2012. The effect of photoperiod on larval culture performance of two marine finfish species. *Aquaculture* 360-361:54-57.

Tosh, C.A., J. Steyn, H. Bornemann, J. van den Hoff, **B.S. Stewart**, J. Plotz and M.N. Bester. 2012. Marine habitats of juvenile southern elephant seals from Marion Island. *Aquat Biol* doi:10.3354/ab00463.

Wellehan, J.F.X. Jr., **R. Rivera**, L.L. Archer, **C. Benham**, J.K. Muller, K. M. Colegrove, F.M.D. Gulland, J.A. St. Leger, S.K. Venn-Watson and **H.H. Nollens**. 2011. Characterization of California sea lion polyomavirus 1: expansion of the known host range of the Polyomaviridae to Carnivora. *Infec Ge Evol* 11:987-996.

Williams, J., J. Claisse, D. Pondella II, L. Medeiros, C.F. Valle, and **M. Shane**. 2012. Patterns of life history and habitat use of an important recreational fishery species, spotfin croaker, and their potential fishery implications. *Mar Coastal Fish: Dyn Mgmt Ecosys Sci* 4:71-84.