Publications and Presentations authored by SLEWTHS or contributed to by SLEWTHS staff and animals.

Hurley, J., Skrovan, S., Yeager, H., (2006) **Mapping molting patterns in 3.1 California sea lions (Zalophus californianus)** Poster presentation for the 34th annual IMATA conference, Oahu, HI.

Beginning in February, 2004, the S.L.E.W.T.H.S. (Science Learning and Exploration with the Help of Sea lions) project in Moss Landing, California, began taking an in depth look at the molting process of 3.1 California sea lions (Zalophus californianus) in order to create a qualitative and quantitative representation of the animals' annual molt. Waterproof bandages were used to collect loose fur samples at eight representative spots on the sea lions' bodies; photographs were taken to obtain qualitative data. The animals were trained to maintain stationary positions for up to two minutes in order for photographs to be taken and bandages to be applied and removed. This study has created a foundation upon which further research can occur; results and ongoing research will be discussed.

Hurley, J. (2006) **Training workshop.** Formal workshop at the 6th annual ABMA conference, San Diego, CA.

Lichman, D. and Hurley, J. (2005) **PARELLI NATURAL HORSEMANSHIP: Using species specific traits to enhance behavior modification.** Formal presentation for the 5th annual ABMA conference, Houston, TX.

Pat Parelli has developed a system for teaching horsemanship to the general public. This system takes its foundation from characteristics of horse herd behavior used in establishing dominance and in pair bonding. At the highest level of accreditation offered by Pat Parelli, David Lichman engaged in a unique collaboration with Dr. Hurley and her collection of sea lions to examine similarities and differences in training techniques. The conclusion is that although standard operant conditioning principles will always apply – knowledge of species-specific behaviors can both enhance and accelerate the training process. This project produced a fun and entertaining short subject film "The Challenge" in which Jenifer and David demonstrate similar behaviors with a California sea lion and a Tennessee Walking Horse. Excerpts from the film will be presented, along with some video footage of horses playing dominance games at liberty in a pasture.

Hurley, J., and Skrovan, S., (2005) **Training California sea lions (Zalophus californianus) to operate in remote and challenging environments.** Formal presentation at both the 5th annual ABMA conference, Houston, TX, and the 33rd annual IMATA conference, Florida Keys, FL.

Animal Training and Research International houses 3.1 California sea lions used for both scientific research and public display. The development of our diverse programs has necessitated training our collection to work comfortably in many overwhelming and complex environments. We have successfully trained our collection to do numerous research projects under free-release conditions in the open ocean. The same animals are also trained for public outreach programs in remote transportable facilities. Some of the most challenging work has been to condition these animals for various types of movie or studio performance situations, where limited prior preparation and variable complex environments are inherent to the medium. California sea lions, as exotic and somewhat flighty animals by nature, can be a challenge to prepare for constantly changing conditions and environment. We will discuss the desensitization techniques used to prepare animals to transition easily into new and challenging environments, context shift issues, cage and transport training.

Kordowski, A. and Hurley, J. (2005) **Basic Training Concepts- back to basics.** Formal workshop at the 5th annual ABMA conference, Houston, TX.

The purpose of this outline is to present both apprentice and experienced trainers with a quick reference guide to animal training basics using positive reinforcement. The emphasis is placed upon developing practical skills which can be applied to all situations. Technical terms are included and defined where applicable, but should not be viewed as a substitute for a training manual or for a vocabulary list. Animal training is a field in which there are no set solutions to any problem. This does not mean that the framework in which trainers operate is equally unstructured. The basic rules of animal training are the backbone of any successful training technique. This outline will present basic techniques of operant conditioning, bridge training and use, reinforcement concepts, and the importance of clear training staff communication. By reviewing the following information, experienced trainers will also benefit. The ideal way to handle any training problem is to prevent it from occurring. Effective application of training basics is the most important method to accomplish this goal. This outline can serve as a valuable reminder to “go back to the basics” whenever a difficult situation is encountered.

Harper, C.G., Xu, S., Rogers, A.B., Feng, Y., Shen, Z., Taylor, N.S., Dewhirst, F.E., Paster, B.J., Miller, M., Hurley, J., Fox, J.G. (2003). **Isolation and characterization of novel Helicobacter spp. From the gastric mucosa of harp seals *Phoca groenlandica*.** Diseases of Aquatic Organisms. 57(1-2): 1-9.

Since the recent discovery of *Helicobacter cetorum* in cetaceans and its role in the development of gastritis, speculation has existed as to whether pinnipeds have *Helicobacter spp*. associated gastritis and peptic ulcer disease. The gastric mucosa of 4 stranded harp seals *Phoca groenlandica* from the Massachusetts coastline were assessed for *Helicobacter spp*. by culture and PCR. We cultured 2 novel *Helicobacter spp*. from the pyloric antrum of 1 of the 4 harp seals studied, and identified these by PCR in 2 of the

4 seals. Both gram-negative bacterial isolates were catalase-and oxidase-positive. However, a fusiform helicobacter with flexispira morphology was urease-positive, and a spiral-shaped helicobacter was urease-negative. Slender, spiral and fusiform-shaped bacteria were detected in the gastric mucosa by the Warthin-Starry stain. Histopathologic analysis revealed mild diffuse lymphoplasmacytic gastritis within the superficial mucosa of the pyloric antrum of both infected seals, The 2 bacterial isolates were classified by 16S rRNA analysis; they clustered with other enteric helicobacters and represent 2 novel Helicobacter spp. The urease-negative bacterial isolate clustered with H. canis and the urease-positive isolate clustered with an isolate from a sea lion and isolates from sea otters. This cluster of pinniped isolates has 97% similarity to a number of Helicobacter species, but appears to be most closely related to other helicobacters with flexispira morphology. These findings suggest that the novel *Helicobacter spp*. may play a role in the etiopatho-genesis of gastrointestinal diseases in pinnipeds. To our knowledge, this represents the first isolation and characterization of a novel *Helicobacter spp*. from pinnipeds.

Fish, F.E., Hurley, J., Costa, D.P. (2003). **Maneuverability by the sea lion *Zalophus californianus*: turning performance of an unstable body design.** Journal of Experimental Biology. 206(4): 667-674.

Maneuverability is critical to the performance of fast-swimming marine mammals that use rapid turns to catch prey. Overhead video recordings were analyzed for two sea lions (*Zalophus californianus*) turning in the horizontal plane. Unpowered turns were executed by body flexion in conjunction with use of the pectoral and pelvic flippers, which were used as control surfaces. A 90 degree bank angle was used in the turns to vertically orient the control surfaces. Turning radius was dependent on body mass and swimming velocity. Relative minimum radii were 9-17% of body length and were equivalent for pinnipeds and cetaceans. However, Zalophus had smaller turning radii at higher speeds than cetaceans. Rate of turn was inversely related to turn radius. The highest turn rate observed in Zalophus was 690 degrees s super(-1). Centripetal acceleration measured up to 5.1 g for Zalophus. Comparison with other marine mammals indicates that Zalophus has a morphology that enhances instability, thus providing enhanced turning performance. Enhanced turning performance is necessary for sea lions to forage after highly elusive prey in structurally complex environments.

Hurley, J.A., Lewis, W., Skrovan, S., Harper, C., and Fox, J. (2002) **Stomach ulcers in marine mammals.** Poster presentation for the 30th annual IMATA conference, Orlando, FL.

In humans and animals, stomach ulcers have long been associated with stress; however, it is now widely accepted that peptic ulcers in humans are caused by chronic inflammation due to a Helicobacter pylori bacterial infection. It has also become clear that many other mammals harbor different species of the genus Helicobacter. A new Helicobacter species has recently been found in stomachs of dolphins and beluga whales and has been linked

to gastritis and gastric ulcers observed both in wild and captive cetaceans. Due to the significant presence of stomach ulcers in sea lions and the link between ulcers and Helicobacter in other animals, the SLEWTHS (Science Learning and Exploration With The Help of Sea lions) Project, in collaboration with MIT, began an investigation into peptic ulcer disease in pinnipeds. Investigators at MIT have successfully isolated a novel Helicobacter bacterium from the feces of two California sea lions in both PCR and culture. Using trained voluntary medical procedures the SLEWTHS project collected saliva, blood, gastric fluid and fecal samples from four California sea lions to determine the best method to screen for the bacteria. Current research is in progress to ultimately determine a treatment regime.

Hurley, J.A., Stephens, A., and Skrovan, S. (2002) **The effects of instrumentation on a diving sea lion: The advantages of being naked.** Formal presentation for the 30th annual IMATA conference, Orlando, FL.

Considerable understanding of the behavior and physiology of marine mammals has been obtained by placing a variety of instrumentation such as cameras, data loggers, TDRs and other equipment onto wild animals. However, little has been done to investigate the side effects of this instrumentation. The SLEWTHS (Science Learning and Exploration With The Help of Sea lions) project at Moss Landing Marine Laboratories used trained California sea lions diving in the open ocean to explore some of the possible effects of these instruments. To accomplish this, the sea lions had to be trained to perform control dives, free released in the ocean, completely naked, wearing no tracking devices, harnesses, or tethers of any kind. Dive times and respiratory rates were recorded and compared to sea lion dives while wearing a harness, an underwater camera, and an underwater EKG monitor. The training procedures for these behaviors, as well as the results of this research will be presented.

Hurley, J.A., Wurts- Skrovan, S., and Richter, B.P. (2001) **Training sea lions and humans for ocean free-diving.** Formal presentation for the 29th annual IMATA conference, Albuquerque, NM. (Received First Place AWARD for research advancements).

The best human free divers in the world have trained their bodies to mimic the remarkable diving adaptations of marine mammals. The SLEWTHS (Science Learning and Experimenting With The Help of Sea lions) project at Moss Landing Marine Labs used trained California sea lions in a cooperative research venture to compare the natural dive response of sea lions and the trained dive response of world-champion human free divers. Both humans and sea lions were required to retrieve an object from a designated depth in order to assure the desired dive was successfully achieved. The sea lions were trained to wear a waterproof EKG monitor in order to record their heart rates while performing trained open ocean dive of up to 200 feet. In addition, lactate production in the sea lion blood was analyzed through voluntary bloods ticks after the sea lion surfaced. These dives occurred side-by-side with the human free divers following the same

protocols. The training procedures for these behaviors, as well as the results of this research will be presented.

Orr, A.J., and Harvey, J.T. (2001) **Quantifying errors associated with using fecal samples to determine the diet of the California sea lion (*Zalophus californianus*).** Canadian Journal of Zoology. 79(6): 1080-1087.

The purpose of this study was to quantify the errors associated with using fecal samples to determine the diet of the California sea lion (*Zalophus californianus*). Fishes and squids of known size and number were fed to five sea lions held in enclosures with seawater-filled pools. Enclosures were washed and pools were drained periodically so that sea lion feces could be collected using a 0.5 mm mesh bag. Fish otoliths and squid beaks were collected from feces and used to estimate number and size of prey eaten. An average of 50.7% (SE = 6.4%) of 430 fishes and 73.5% (SE = 12.0%) of 49 cephalopods fed to sea lions were represented by otoliths and beaks in feces, respectively. Estimated lengths of fish from feces were less than lengths of fish fed to sea lions by an average of 30.1% (SE = 2.8%). Beaks were not digested significantly; estimated lengths of squid were underestimated by an average of only 3.3% (SE = 1.5%) relative to actual lengths. Passage rates of otoliths varied, but more than 70% were recovered within 48 h after the fish was consumed. Passage rates of beaks were generally less than those of otoliths; six beaks (11%) were collected in feces 4 days after the squid were eaten. Correction factors were created to more reliably estimate the number and size of fishes and cephalopods eaten by California sea lions.

Deifour, F., and K. Marten. (2001). **Mirror image processing in three marine mammal species: killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*) and California sea lions (*Zalophus californianus*).** Behavioral Processes. 53(3): 181-190.

Dolphins (*Tursiops truncates*) and their relatives might be expected to show mirror-induced contingency checking, a prerequisite to self-recognition, because of their high brain development, their complex social life and their demonstrated abilities in bodily imitation. A study of killer whales' (*Orcinus orca*) behavior in front of a mirror is presented, including a mark test. Shorter investigations of mirror behavior are also described in false killer whales (*Pseudorca rassidens*) and California sea lions (*Zalophus californianus*). Contingency checking was present in killer whales and possibly also in false killer whales, but no clear contingency checking was observed in sea lions. The mark test on killer whales suggested that the marked animal anticipated that its image would look different. This study shows that killer whales and false killer whales, like bottlenose dolphins, appear to possess the cognitive abilities required for self-recognition.

Harvey, J.T., Hurley, J.A., and Wurts, S. (2001). **Training California sea lions to record whale behavior using a rehabilitating California gray whale calf. JJ: The**

rescue, rehabilitation, study and release of an infant California gray whale, *Eschrichtius robustus*. Aquatic Mammals. 27(3); 289-293.

The goals of the SLEWTH (Sea Lions Exploring Whales and Their Habitats) project were to train California sea lions to carry a harness with attached video camera and swim alongside whales, thus recording their underwater behaviors. The sea lions had been trained to wear a harness with attached video camera housing, enter and exit the ocean from vessels or shore, swim alongside a moving vessel, and recognize verbal commands from an underwater speaker. These sea lions also were trained to swim alongside a replicate of a whale being pulled by a vessel, and would swim alongside captive dolphins as the first approximation of swimming abeam of whales in the wild. The presence of JJ at SeaWorld provided a unique opportunity and the next logical step for desensitizing the trained sea lions to the presence of a large cetacean in a controlled setting. The two sea lions were transported to SeaWorld of San Diego, and during a 3-week period slowly introduced into JJ's tank, moved stepwise closer to JJ, and eventually trained to swim in close proximity (within 0.5 m) to JJ. We never observed any significant changes in JJ's behavior (either interest or disturbance) when the sea lions were in visual contact with JJ. The brief study demonstrated that the California sea lions could be transported a long distance, while maintaining their trained behaviors, desensitized to the presence of a captive large cetacean, and perhaps familiarized JJ with a species she would encounter in the wild after release. We believe experience at SeaWorld displayed the potential of training sea lions to carry instruments for monitoring the underwater behaviors and movements of free-ranging whales.

Hurley, J.A. and Costa, D.P. (2001). **Standard metabolic rate at the surface and during trained submersions in adult California sea lions (*Zalophus californianus*)**. J. Exp. Biol. 204(19): 3273-3281.

The metabolic rate (MR) of four adult California sea lions (*Zalophus californianus*), two males and two females, was quantified during trained submersion and stationing behavior in laboratory tanks. MR was measured, at rest and for single submersions of increasing duration (1-7 min), by measuring oxygen consumption using open-circuit, indirect calorimetry. Standard MR was measured under conditions defined for basal MR and was found to be 1.9 to 3 times that predicted for terrestrial animals of similar size. Submersion MRs were calculated from the post-submersion oxygen debt and declined to as little as 47 % of standard MR on the longest submersions. This hypometabolic response was proportional to the duration of submersion and was greatest for the maximum duration submersions. Short submersions produced MRs equivalent to measured standard MR. These data suggest that although California sea lions maintain an elevated metabolism under standard conditions, they are capable of reducing their metabolism in response to the needs of diving. Such metabolic flexibility enables sea lions to moderate their oxygen use during diving and to extend their aerobic diving capability.

Hurley, J.A., Skrovan, S., Fink, T., and Hunizker, T. (2000) **The SLEWTHS project at Moss Landing Marine Labs.** Poster presentation for the 28th annual IMATA conference, Cancun, MX. (Received conference AWARD)

The SLEWTHS (Science Learning and Experimenting With The Help of Sea lions) project has gone though many evolutions in the last few years. Although many remember SLEWTHS housed at Long Marine Lab and using a floating pen in the ocean to film whales, both location and focus have changed. After building and moving into a new facility at Moss Landing Marine Labs, the project is currently focused on education, research, and teaching public conservation through its new Sea Lion Stewards program. Are you bombarded with the question "How do I become an animal trainer?" – send them to us! The SLEWTHS project now offers a beginning marine mammalogy certificate program consisting of both in-depth classroom and hands-on learning. In addition to week-long internships working with our sea lions, two classes are offered for college credit through CSUMB (California State University at Monterey Bay). The *Working With Marine Mammals* class is an overview of the marine mammal industry, jobs, laws, and skills. We also offer a very detailed animal training class called *Techniques and Theories of Animal Training*. Research is still a focus for our project, both in the facility pools and the open ocean, with experiments ranging from physiology and feeding studies to hydrodynamics. In addition, our new Sea Lion Stewards program is a community outreach project to motivate and reward participants of all ages for cleaning our beaches and recycling.

Hurley, J., and Skrovan, S. (2000). **Training sea lions to film marine life** Formal presentation to the 28th annual IMATA conference, Cancun, MX.

The SLEWTH project at Moss Landing Marine Labs was designed with the formidable goal of teaching sea lions to film whales. This presentation will outline the methods and approximations used to teach the sea lions to swim with and film whales and other marine life. First, the sea lions were taught to pattern human movement using bridge and target techniques. This behavior was then captured with dolphins and other sea lions. Finally, the behavior was transferred to whales in the ocean using intermediate steps of a model whale and a life whale in a pool setting. Although the training was a success, logistical difficulties with camera drag prohibit the efficient use of this technique as a research tool.

Sousa, M., Hurley, J.A., and Costa, D.P. (1998). **Reducing the risk of anesthesia in California sea lions, *Zalophus californianus*.** Marine Mammals: Public Display and Research. 3(1): 48-56.

The use of anesthesia is an important tool for captive animal husbandry. However, risks are often associated with the anesthetic agent or the physical restraint used with the induction of the anesthetic. The risks to both the animal and staff can be minimized by training the animals for anesthesia. Over a course of six months, we trained four

California sea lions (*Zalophus californianus*) to cooperate with the anesthesia procedure. The animals were taught to allow a voluntary pre-anesthetic injection, to enter an induction chamber or restraint cage, and to accept the restraint bars voluntarily. During the procedure, body temperature was monitored with both rectal probe and temperature telemeters. We found an average drop of 4.6oC (SD +0.6, n=4). We also compared a chamber induction technique to a medical (restraint) cage induction and the use of isoflourane versus halothane gas inhalant. Training reduced or eliminated physical injuries to the animal and trainers. Optimal anesthesia was accomplished using isoflourane with a chamber induction technique.

Hurley, J.A. and Holmes, N. (1998). **A review of the psychological principles and training techniques associated with desensitization.** Marine Mammals: Public Display and Research. 3(1): 16-26.

Habituation is defined classically as "the relatively persistent waning of a response as a result of repeated stimulation which is not followed by any kind of reinforcement" (Thorpe, 1956). In the authors' opinion the desensitization process is an integral part of many aspects of an animal training regime involving the incorporation of both habituation and counter-conditioning practices. It is necessary for preparing an animal to accept novel stimulus, to operate in a novel environment, and to interact with apparent confidence and consistency in captivity (Flaherty, 1985; Goldblatt, 1993). A literature search on the topic is summarized and used to elaborate on conventional animal training desensitization practices.

Hurley, J.A. (1997). **Assessing the educational value of marine mammal show presentations.** Invited presentation to the Alliance Marine Educators Meeting, Chicago

The marine mammal protection Act codifies that a public display facility must have "a program for education or conservation purposes." There have been claims by animal rights groups that there is no evidence that a live marine mammal show presentation can have an educational value. In order to test such claims, a pilot experiment was performed at Long Marine Laboratory which focused on the effectiveness of a live marine mammal presentation as an educational vehicle. School children from fourth and fifth grade classes were divided randomly into two groups: a treatment group which watched a live presentation involving a sea lion and two dolphins, and a control group which saw a video of the exact same presentation in their classroom. All children took a pre-test and a post-test in the classroom to assess background experience and changes in attitude and knowledge. Results indicate a 20% average increase in knowledge in both the treatment and control groups, indicating that a live presentation can certainly operate as an educational vehicle. Further, there was a demonstrable positive attitude change in the live experience group which was very statistically significant ($p=0.000029$) different from the neutral attitude change manifested by the control group.

Norman, H., Hurley, W.C., and Hurley, J.A. (1997). **Voluntary flipper tagging of a California sea lion (*Zalophus californianus*).** Poster presentation to the 25th annual IMATA conference, Baltimore, MD.

The SLEWTH project (Sea Lions Exploring Whales and their Habitats) uses trained sea lions in the open ocean as research tools. After several years of residency and preparatory training at Long Marine Laboratory, we were prepared to move the second of our California sea lions to begin ocean work in the Monterey Bay. Prior to free release training, the National Marine Fisheries Service required that identification tags be placed in the sea lion's fore flipper. To place the tag, we considered the options of physical restraint, anesthesia, or training. The staff chose to use trained behavior rather than risking potential injury to the animal. Using operant conditioning, the sea lion was trained to accept multiple injections of a local anesthetic prior to coring out tissue in the flipper. The one hour procedure involved four voluntary injections of Lydocaine, followed by tissue removal with a biopsy punch. It concluded with successful tag placement using roto-tag pliers. The procedure once again proved the value of training when considering the animal's welfare, as well as maintaining the relationship we foster with our animals.

Hurley, J.A., Wurts, S., and Harvey, J.T. (1997). **Training California sea lions (*Zalophus californianus*) to record undersea phenomena for research purposes.** Formal presentation to the 25th annual IMATA conference, Baltimore, MD. (Received conference AWARD).

As a result of man's inherent shortcomings underwater, relatively little is known about the undersea world in general. This is especially true of sporadically located, transient animals such as whales. Observations and film from boats, scuba divers, or submersibles can produce a biased behavioral view because of the close human presence. Additionally, human beings are not well-equipped for repetitive, deep, or long underwater excursions. These logistical barriers have constrained scientific studies; consequently most studies have poor replication, limited inferences because of the research techniques, and restricted geographical applicability. In order to develop a new method of investigating marine animals, we have trained two California sea lions to wear video camera backpacks and cooperate under free-release conditions in Monterey Bay, California. The SLEWTH (Sea Lions Exploring Whales and Their Habitat) project has been operating from a free-standing 'island' pen since the fall of 1996. Our progress-to-date, training methods, and wild encounters will be presented.

Hurley, J.A. (1996) **Metabolic rate and heart rate during trained dives in adult California sea lions.** Doctoral thesis. University of California at Santa Cruz.

For marine mammals, it has been historically difficult to measure the costs associated with foraging, due to their large size and ocean habitat. This study quantified the

metabolic rate and heart rate of four adult California sea lions (Zalophus californianus), two males and two females, during trained diving behaviors in laboratory tanks. Metabolic rate (MR) and heart rate (HR) were measured at rest, for single dives of increased duration (1-7 minutes), and during sequences of pattern diving. MR was determined by measuring oxygen consumption using open-circuit, indirect calorimetry; HR was measured using a holter monitor recorder providing EKG tracings. Standard metabolic rates (SMRs) were measured under conditions defined for the measurement of basal metabolism; nevertheless, they resulted in metabolic rates that were 2-3 times those predicted for terrestrial animals of similar size. On single dives, metabolic rate was reduced significantly to 55% of SMR on maximum duration dives. This hypometabolic response was graded with dive duration and the shorter duration dives were carried out at SMR. Similarly, single dive HRs declined with increasing dive duration to 19% of surface resting values on maximum duration dives. MRs and HRs were also measured during diving patterns based on wild female California sea lion diving behavior. The reported mean surface interval of 1.5 min was separately paired with 1, 2, and 3 min dive durations to explore the relationship between oxygen loading time and foraging time. A fourth pattern simulated wild Australian sea lion females' (Neophoca cinerea) average foraging pattern for comparison with the California sea lion pattern. MRs during pattern diving were not substantially different than SMR for all patterns tested; however, the wild California sea lion pattern resulted in the lowest MR and the lowest weighted average heart rate. An analysis of the relationship between MR and HR during diving indicates that there is a promising predictive potential; however, it may be sex or size specific. A variable HR and MR including an option for hypometabolism, provide sea lions with a wide variety of strategies for reducing oxygen use during diving. Thus, a limited O_2 reserve is conserved for optimal foraging.

Sousa, M., Long, B., Hurley, J.A., Hurley, W., Wurts, S. (1995). **Novel enrichment ideas on a researcher's budget.** Poster presentation to the 23rd annual IMATA conference, Las Vegas, NV.

At Long Marine Laboratory (LML), University of California, Santa Cruz, research is our primary goal. The research is mainly funded by small, soft-money grants. Unfortunately, after the cost of food and maintenance, there are limited surplus funds. Nevertheless, we recognized the enormous value of environmental enrichment in any captive animal's life, so we were led to create low budget environmental enrichment tools for the California sea lions (*Zalophus californianus*) and Atlantic bottlenose dolphins (*Tursiops truncates*). Environmental enrichment ideas presented include: m multi-species interaction, excursions to new environments and recycling old toys. We will also present an inexpensive multi-faceted PVC platform that provides additional deck space for training, haul-out and shade, and an underwater obstacle course. Furthermore, we will offer a recording sheet that was developed to minimize the likelihood of the animals becoming desensitized to the toys through inadvertent overexposure.

Clark, L., Passamaneck, Y., Hurley, J.A., Hurley, W.C., Wurts, S., Williams, T.M., Costa, D.P. (1995). **Highlights of training assisted research at Long Marine Lab.** Poster presentation to the 23rd annual IMATA conference, Las Vegas, NV.

Joseph M. Long Marine Laboratory (LML) is a leading center of marine research in the United States. The facility provides public educational programs and tours year-round as well as supporting dozens of marine mammal research projects. Much of the research utilizes trained voluntary behavior to obtain meaningful scientific data. Presented will be research utilizing trained behavioral control exploring foraging energetics, swimming and diving energetics, morphometrics, thermoregulation, blood parameters, and field equipment testing on California sea lions (*Zalophus californianus*) and Atlantic bottlenose dolphins (*Tursiops truncates*). Such research is offered to provide insight and directions for exploration for public display facilities looking to contribute to research efforts.

Fadely, B.S., Zeligs, J.A., and Costa, D.P. (1994). **Assimilation efficiencies and maintenance requirements of California sea lions (*Zalophus californianus*) fed walleye Polock (*Therangra chalcogramma*) and herring (*Clupea harengus*)**. Submitted to National Marine Mammal Laboratory Alaska Fisheries Science Center National Marine Fisheries Service.

Hypotheses of nutritional stress induced by dietary shifts have been considered as possible causes for the decline of Steller sea lions (*Eumetopias jubatus*) in Alaska. This dietary shift may have involved a switch from relatively higher-fat content fish (such as herring) to lower-fat species (such as Pollock). Relatively few studies have been performed measuring the maintenance intake requirements and assimilation efficiencies of pinnipeds on such diets. This study measured the assimilation efficiency and maintenance intake requirements for herring and Pollock diets fed to three captive California sea lions (*Zalophus californianus*). Although caloric densities and lipid content of the Pollock diets were less than that of herring diets, there was no significant difference in the assimilation efficiency requirements on both diets scaled to body mass similar to other Otariid studies. We conclude that if Steller sea lions have been impacted by nutritional stress through dietary shifts, it was not due to poorer assimilation or nutritional quality once prey were captured, but rather a result of changes in prey abundance or energetic costs associated with foraging.

Williams, L., Wurts, S., Zeligs, J., and Costa, D. (1993). **Timed behaviors: extended stationing with California sea lions.** Formal presentation at the 21st annual IMATA conference, Kona, HI.

For the sea lion physiology project at Long Marine Laboratory, special research conditions require prolonging various stationing behaviors. These came to be called "timed behaviors," since they involved long intervals of the animal continuously performing the requested behavior. Taken to the extreme, a station could be held for up

to an hour, often continuing with only verbal praise for 30 minutes at a time. The methods used to extend and maintain the behaviors will be discussed, as well as problems encountered and their solutions. The timed behaviors are not only invaluable in research situations, but are also used in daily activities including medical and separation behavior.

Zeligs, J.A., Holmes, N., DeSantis, B., and Costa, D.P. (1993). **Desensitization: Psychological principle versus training technique.** Formal presentation to the 21rst annual IMATA conference, Kona, HI.

Desensitization is defined classically as "the relatively persistent waning of a response as a result of repeated stimulation which is not followed by any kind of reinforcement" (Thorpe, 1956). The desensitization process is an integral part of many aspects of an animal training regime. It is necessary in order to prepare an animal to accept novel stimulus, to operate in a novel environment, and to interact confidently in captivity. A literature search on the topic is summarized and used to elaborate on conventional animal training desensitization practices.

Zeligs, J.A., Cover, K.C., and Costa, D.P. (1991). **Teaching people to train animals.** Formal presentation and publication in the proceedings to the 19th annual IMATA conference, Concord, CA.

Programs to train volunteers, clients, and staff to handle and train animals are outlined. A manual of field training techniques, as presented in these programs, is introduced. These programs have resulted in exceptional trainers and excellent safety records, as well as consistency amongst the entire working group. They have allowed innovative applications of operant conditioning, particularly by bride and target technique, such as: capuchin monkeys trained to aid quadriplegics, pigeons as aids to the sightless, cows trained to tell researchers when they were sexually receptive, pigs to allow blood sampling from the vena cava, and the unanesthetized polar bear tooth inspections and hair sampling. In these financially stringent times, optimization of employee efficiency and effective volunteer labor can make a critical difference to our operations.

Zeligs, J. and Costa, D.P. (1990). **Trained complex veterinary procedures in *Zalophus californianus* at UCSC Long Marine Lab**. Formal presentation and publication in the proceedings to the 18th annual IMATA conference, Chicago, IL.

The training and use of voluntary veterinary procedures with captive animals has many advantages: reduced stress on the animal, reduced risk of injury to the animal and to the handler, improved access to valuable medical information, facilitation of research (esp. physiology), and reduced artifacts promoted by stressful restraint procedures. For these reasons we trained our California sea lions to perform various complex veterinary procedures; including full body examination; throat culturing and tooth cleaning; blood sampling; ultra sound examination; and squeeze cage work including lie down positioning and toleration of squeeze bars pressing on the body. All of the above

procedures were successfully trained with 2 – 2 year old female sea lions in roughly 9 months time. This paper is intended to present the feasibility and effectiveness of training voluntary cooperation in complex veterinary procedures in Zalophus californianus.