ASSOCIATION OF ZOOS & AQUARIUMS

# Japanese Spider Crab (*Macrocheira kaempferi*) CARE MANUAL

CREATED BY THE
**AZA Aquatic Invertebrate Taxon Advisory Group**
IN ASSOCIATION WITH THE
**AZA Animal Welfare Committee**

## Japanese Spider Crab (Inachidae/*Macrocheira*) Care Manual

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# Introduction

**Preamble**

AZA accreditation standards, relevant to the topics discussed in this manual, are highlighted in boxes such as this throughout the document (Appendix A).

AZA accreditation standards are continuously being raised or added. Staff from AZA-accredited institutions are required to know and comply with all AZA accreditation standards, including those most recently listed on the AZA website (http://www.aza.org), which might not be included in this manual.

## Taxonomic Classification

Table 1. Taxonomic classification for *Macrocheira kaempferi* (Temminck, 1836).

| Classification | Taxonomy | Additional information |
|---|---|---|
| Kingdom | Animalia | |
| Phylum | Arthropoda | Subphylum Crustacea |
| Class | Malacostraca | |
| Order | Decapoda | |
| Infraorder | Brachyura | True crabs |
| Superfamily | Majoidea | Spider crabs |
| Family | Inachidae | 38 genera |
| Synonyms | *Maja kaempferi, Macrocheira ginzanensis* | Invalid names that may be found in older literature |

## Genus, Species, and Status

Table 2. Genus, species, and status information for Japanese spider crab

| Genus | Species | Common Name | USA Status | IUCN Status | AZA Status |
|---|---|---|---|---|---|
| *Macrocheira* | *kaempferi* | Japanese spider crab | Not listed | Not evaluated | Not Cooperatively Managed |

## General Information

The information contained within this Animal Care Manual (ACM) provides a compilation of animal care and management knowledge that has been gained from recognized species experts, including AZA Taxon Advisory Groups (TAGs), Species Survival Plan® Programs (SSPs), biologists, veterinarians, nutritionists, reproduction physiologists, behaviorists and researchers (visit the AZA Animal Program page to contact the TAG Advisors). They are based on the most current science, practices, and technologies used in animal care and management and are valuable resources that enhance animal welfare by providing information about the basic requirements needed and best practices known for caring for Japanese spider crab (JSC) populations in aquaria. This ACM is considered a living document that is updated as new information becomes available and at a minimum of every five years.

Information presented is intended for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the ACM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent AZA accreditation standards of care unless specifically identified as such in clearly marked sidebar boxes. AZA-accredited institutions which care for JSCs must comply with all relevant local, state, and federal wildlife laws and regulations; AZA accreditation standards that are more stringent than these laws and regulations must be met (AZA Accreditation Standard 1.1.1).

**AZA Accreditation Standard**

**(1.1.1)** The institution must comply with all relevant local, state/provincial, and federal wildlife laws and regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and regulations. In these cases the AZA standard must be met.

The ultimate goal of this ACM is to facilitate excellent JSC management and care, which will ensure superior JSC welfare at AZA-accredited institutions. Ultimately, success in our JSC management and care will allow AZA-accredited institutions to contribute to JSC conservation, and ensure that JSCs are in our future for generations to come.

In Japan, laws prohibit fishermen from harvesting JSCs during mating season (early spring, from January until April), in order to try to maintain appropriate recruitment to the population. Other than as a product of fisheries in Japan, JSCs are not currently regulated. Normal trade regulations apply, and a 3-177 United States Fish and Wildlife Service live animal importation document is needed to import them into the United States for display in public aquaria.

JSCs are a marine decapod crustacean found primarily in the central to southern waters of Japan, more specifically, the Pacific side of the Japanese islands, Konshu and Kyushu, at a latitude roughly between 30 and 40 degrees North, with some populations discovered in the deeper waters of Su-ao, Taiwan. This species is found at water depths of 50 to over 500 meters (164 to over 1640 ft.). It has the largest leg span of any arthropod, reaching up to 3.8 meters (12.5 ft.) and weighing up to 19 kg (42 lb.). Adults may perform breeding migrations into shallower waters. (Tanase 1967). The coloration of JSC is a mottled reddish orange dorsally, transitioning to the ventral base of a cream white color. Animals cared for in aquaria tend to be more brightly colored after molting. Males have elongated chelipeds, and females have a wider apron.

The original description of this species was in: Coup-d'oeil sur la faune des Iles de la Sonde et del'Empire du Japon. Discours préliminaire destiné a servir d'introduction a la Faune du Japon (roughly translated: A view of the wildlife of the Islands of Sunda and empire of Japan. Preliminary Discourse was intended as an introduction to the Wildlife of Japan; Temminck, 1836). Figure 1 illustrates the anatomy of the JSC. Please refer to the diagram for basic terminology. A scientific description of the species, using special nomenclature is as follows:

> “The Japanese spider crab has a subcircular carapace with a number of spiniform tubercles on its surface which are especially erect on the branchial regions. They have a supraorbital eave with a spine in front and behind the eyestalk, the exorbital angle is spiniform, and the hepatic lobe behind it is acute. The rostrum is composed of two slender spines and there is a well-developed interantennular partition, bearing a spine ventrally at its apex. The basal antennal article does not extend forward further than half the diameter of the eyestalk. Japanese spider crabs have chelipeds longer than any of the ambulatory legs. Their merus and palm are especially long and of similar length. The fingers are very short, approximately less than a fourth of the palm length. The ambulatory legs are long and slender with the meri being the longest. The dactyls are simple, slightly incurved, and not prehensile”.

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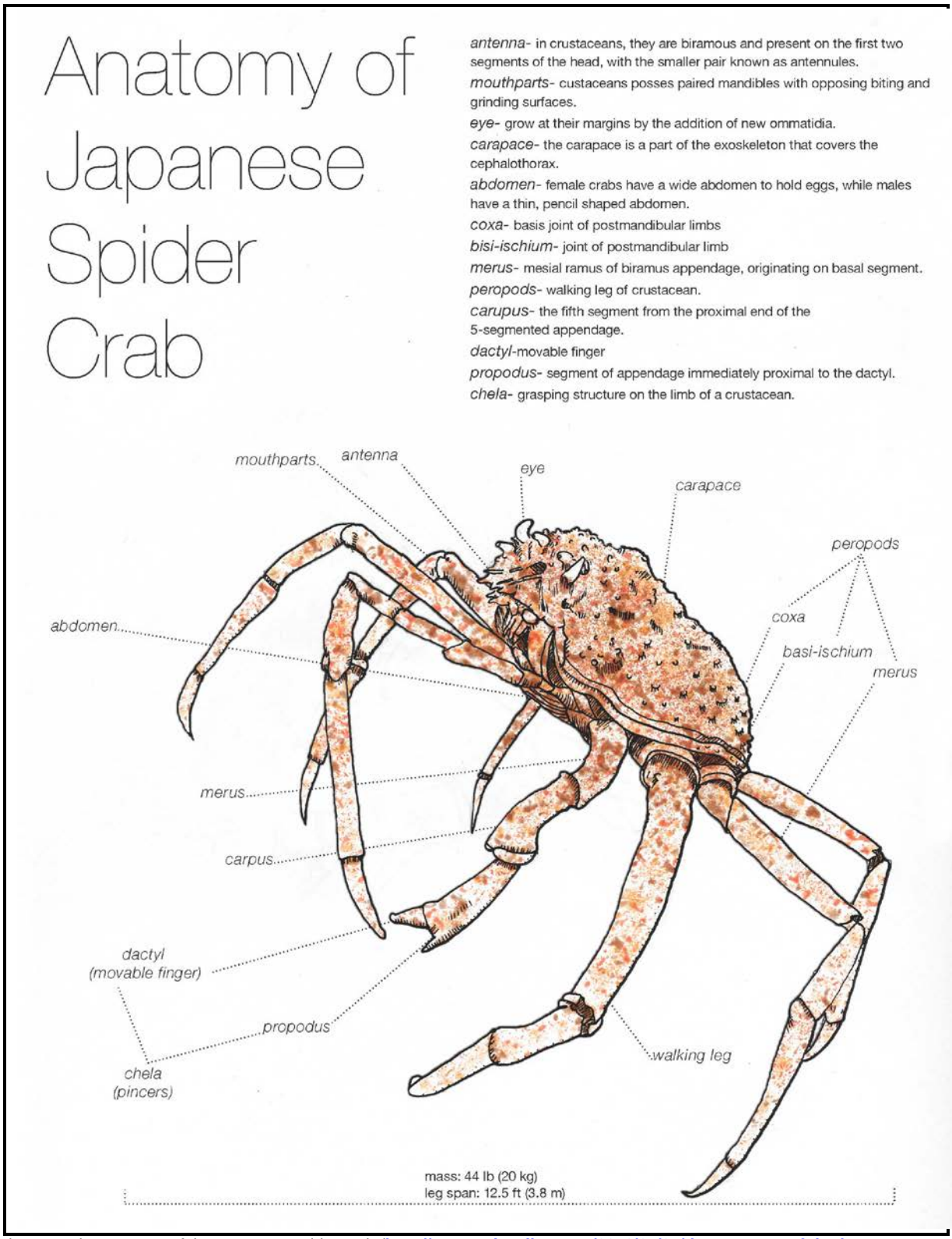


Figure 1. The anatomy of the Japanese spider crab (**http://anastaciavalles.com/2012/04/07/the-anatomy-of-the-japanese-spider-crab/**). Artwork used with permission from Anastacia Valles.

# Chapter 1. Ambient Environment

## 1.1 Water Temperature

The animals must be protected from weather, and any adverse environmental conditions. (AZA Accreditation Standard 1.5.7). Animals typically living in cold-water temperatures should be provided chilled water to match their ideal temperature range. The preferred water temperature range for JSCs is not known with full certainty, although it has been reported that the water temperature in Suruga Bay is typically 10 °C (50 °F) at 300 m (984 ft.) (Myers et al., 2013). A survey of public aquaria in Europe and North America was undertaken to determine what they regard acceptable temperature ranges for managed JSCs are (Appendix F). In this survey, all 29 respondents reported that they maintained the water temperature between 7.2 and 16.1 °C (between 45 and 61°F). Fifty percent of the respondents kept the temperature between 10 and 13 °C (between 50 and 55.4°F). In some instances, other animals in the exhibit with the crabs may have been stenothermic, or preferred temperatures towards one end of the crab's temperature range so that their needs could be met with the relatively eurythermal JSC. Another survey of ten public aquariums reported a temperature range for housing JSC that ranged from 6 to 16 °C (from 42.8 to 60.8 °F), with 90% of the respondents reporting a range of 10 to 16 °C (50 to 60.8 °F). There is no known differing temperature recommendation based on seasonal, gender or age related criteria with JSC, however, seasonal migrations reported to be undertaken by JSCs indicates that temperature could play an important role in their natural history.

**AZA Accreditation Standard**

**(1.5.7)** The animals must be protected from weather or other environmental conditions clearly known to be detrimental to their health.

Unless the holding facility utilizes natural seawater from a temperate ocean, all JSC exhibits and holding systems will require some manner of mechanical cooling to maintain the appropriate water temperature range with as little daily fluctuation as possible. The optimal daily temperature differential should not exceed (plus or minus) 0.5 °C (33 °F). AZA institutions with exhibits which rely on climate control must have critical life-support systems (LSS) for the animal collection and emergency backup systems available, while all mechanical equipment should be included in a documented preventative maintenance program. Special equipment should be maintained under a maintenance agreement or records should indicate that staff members are trained to conduct specified maintenance (AZA Accreditation Standard 10.2.1).

**AZA Accreditation Standard**

**(10.2.1)** Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment must be kept in working order and should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

Refrigeration units are a critical piece of LSS equipment for facilities desiring to maintain JSCs in closed-systems. These units typically consist of a chiller that supplies coolant to a heat exchanger and a thermostat that regulates the flow of coolant to the exchanger based on the water temperature of the aquarium exhibit. Centralized chillers with a re-circulating cold-water (or glycol) loop often offer advantages in energy use, redundancy and efficiency (especially in facilities with multiple cold-water exhibits). Freestanding combined chiller/heat exchanger units may be more economical, (at least based on initial cost) and are used successfully in many facilities with adequate alarm/sensing equipment. The heat exchanger, thermistor bulb and well of the refrigeration units should not have toxic metal components such as copper, brass, or bronze, even if plastic coated, in contact with the water as they can be harmful to the animals. Several companies make reasonably priced units designed for marine aquariums use with titanium heat exchangers. Stainless steel may be an appropriate material, but that is dependent on the grade used and the specific application (in regards to the possibility of crevice corrosion). Before utilizing this material, the advice of an experienced LSS manufacturer or installer should be sought.

Because water temperature is such a critical factor with JSCs, redundant systems and emergency back-ups are important safety features. Monitoring of the water temperature should be made on a frequent enough basis that the operator will be alerted of a system failure prior to the temperature range of the system reaching a point outside the proper range for JSCs. The frequency of these temperature checks may be continual for some automated systems, to a few times per day for manual observations on

large systems that change temperature very slowly. It should not be forgotten that the anticipated time taken to rectify the issue must be included in the calculation of frequency. For example, if an aquarium exhibit system will maintain a suitable water temperature for six hours following a total failure, but it will take two hours to bring the back-up system on-line, then temperature checks should be made at least every four hours for that system—or automated temperature alarms should be employed.

Because there are a wide variety of water cooling methods employed by public aquaria, it is difficult to make recommendations for specific backup systems for JSCs. Having a quarantine aquarium exhibit dedicated to JSCs can also serve as a refugium for the animals should there be a life support failure in their primary exhibit.

## 1.2 Water Quality

AZA-accredited institutions must have a regular program of monitoring water quality for aquatic animals and a written record must document long-term water quality results and chemical additions (AZA Accreditation Standard 1.5.9). Monitoring selected water quality parameters provides confirmation of the correct operation of filtration and disinfection of the water supply available for the collection. Additionally, high quality water enhances animal health programs instituted for aquatic collections.

**AZA Accreditation Standard**

**(1.5.9)** The institution must have a regular program of monitoring water quality for fish, pinnipeds, cetaceans, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

Air quality should be kept at a high standard, where toxic gases are non-existent, and any possible contaminants should be eliminated quickly. For water quality, a regular water quality monitoring program should be in place for all animals housed in AZA-accredited aquariums. Typically run parameters should include temperature, salinity, pH, ammonia levels ($NH_3$), nitrite levels ($NO_2$), and nitrate levels ($NO_3$), with consideration for calcium and alkalinity. Anecdotal information exists that implicates lower than normal iodine levels with problems with crustacean molting, so this value may also need to be tracked. Standard methods can apply for testing water parameters (pH probes, spectrophotometers, etc.). Due to the varying environments in which JSCs can be found, these parameters do have a bit of a range. However, if the parameters fall within these ranges, the JSC will show no ill signs. Whenever possible, being kept in a stable aquatic environment that minimizes fluctuations is preferred.

Ranges for salinity tend to fall between 30–35 ppt, but have been known to dip as low as 29 ppt. A pH range of 7.75–8.40 is usually tolerated well by JSCs. Basic water quality altering substances can be used to decrease or increase pH (e.g., sodium bicarbonate) and have shown no ill effect. Ammonia, nitrite and nitrate levels should all be kept at the normal range for cold saltwater animals. Typically ammonia should be at <0.01 mg/L. Nitrite levels should be kept <0.1 mg/L, and nitrates should be kept at <25 mg/L.

Filtration for JSCs should keep water quality sufficient for proper husbandry. If the enclosure is on a closed-system, a standard set up could include drainage into a sump with filter socks (or other mechanical filtration), then filtered through bio-media, brought up through a chiller, through a High Output (HO) UV sterilizer, into a foam fractionator, and filtered back out through the sump and back into the aquarium exhibit. Basic plumbing issues (leaks, micro-bubbles for example) should all be resolved prior to species introduction. Open systems can use the same basic set up, but can also include large fractionators and sand filters.

## 1.3 Light

Careful consideration should be given to the spectral, intensity, and duration of light needs for all animals in the care of AZA-accredited zoos and aquariums, however, the lighting requirements for JSCs is largely unknown both in terms of intensity as well as photoperiod. It is surmised that these values should mimic that of their natural environment. Photoperiod for JSCs can be set to simulate that of 35 degree North latitude (about that of Tennessee in the United States). Light intensity at depth in Suruga Bay at depth is unknown, but can be estimated as follows: if full sunlight is 100,000 lux, the same light at 150 m (492 ft.) depth would be approximately 1% or 1000 lux. At 300 m (984 ft.), this value drops to 10 lux. This information is derived from estimates made from data on this NOAA web page:
http://oceanexplorer.noaa.gov/explorations/04deepscope/background/deeplight/deeplight.html

The husbandry survey undertaken (Appendix F) shows that of 29 public aquariums answering the questions, 62% kept the JSCs at light levels less than 75 lux. No facility had light levels higher than 1500

lux, while 38% maintained their JSCs at between 75 and 1500 lux. Obviously, higher light levels are more conducive to visitor's observations of these crabs, but these light levels also result in epiphytic algae growth on the crab's shells, with unknown, but probably understated, shell health problems.

## 1.4 Sound and Vibration

Consideration should be given to controlling sounds and vibrations that can be heard by animals in the care of AZA-accredited zoos and aquarium exhibits. Sounds (vibrations) are readily transmitted through water. The speed of sound in seawater is 1560 m/s, and that is 4.5 times faster than in air. Because water is basically uncompressible, sound waves can persist for long distances. In some cases such as with seahorses, vibration produced by the LSS might impose stress on their inhabitants (Anderson et al., 2011). However, it appears that fish become accustomed to vibrations after some time in a managed environment, and the LSS may be perceived as background noise to the animals. No similar study has been performed with JSCs.

Crustaceans do not have ears per se, but they are capable of sensing and reacting to vibrations. JSCs housed in a large plastic vat are seen to react to a light tap on the outside of the vat, and the reaction they have is more or less relative to the strength of the vibration. This is done in order to ascertain health in quiescent crabs; a strong reaction indicates a healthier crab than those that don't react.

Until more is known about the long-term stress of JSCs related to sound produced by the LSS in aquarium exhibits, it would be prudent to reduce vibration levels as much as is practical by isolating pumps and motors from the exhibit, and to reduce the visitors' ability to knock on the exhibit viewing window, perhaps by an off-set like a stanchion, or by a double walled viewing panel.

# Chapter 2. Habitat Design and Containment

## 2.1 Space and Complexity

Prior to committing to and designing a new JSC aquarium exhibit, institutions should consult the AZA Aquatic Invertebrate TAG to identify which crab or related Species Survival Plan® (SSP) populations have the greatest need for the additional spaces you will be providing. This will ensure that your facility is contributing to increasing the SSP's long-term sustainability.

Careful consideration should be given to exhibit design so that all areas meet the physical, social, behavioral, and psychological needs of the species. Animals should be presented in a manner reflecting modern zoological practices in exhibit design (AZA Accreditation Standard 1.5.1). All animals must be housed in enclosures and in appropriate groupings that meet their physical, psychological, and social needs (AZA Accreditation Standard 1.5.2).

**AZA Accreditation Standard**

**(1.5.1)** Animals should be presented in a manner reflecting modern zoological practices in exhibit design, balancing animals' functional welfare requirements with aesthetic and educational considerations.

**AZA Accreditation Standard**

**(1.5.2)** All animals must be housed in enclosures and in appropriate groupings which meet their physical, psychological, and social needs. Wherever possible and appropriate, animals should be provided the opportunity to choose among a variety of conditions within their environment. Display of single animals should be avoided unless biologically correct for the species.

JSCs are benthic invertebrates. They spend all of their time in contact with submerged structure, usually the substrate (Myers et al., 2013). They have been seen climbing artificial rockwork in aquarium exhibits and frequently climb Nitex mesh barriers, and hang perpendicular to the substrate for some time.

It is recommended that the aquarium exhibit have a minimum of 1,500 gallons (5,680 liters) or 1.2 square meters (12–14 square feet) per animal (e.g., a group size of six crabs can be housed in a 9,000 gallon (34,000 liter) aquarium exhibit). Inter-individual distances required by *ex situ* JSCs are not known with certainty. It is generally assumed that more space is better, and at a minimum, there should be enough room for each crab to stand normally, without touching another crab. Given this space, JSCs will often space themselves more or less equally throughout the exhibit. In exhibits with insufficient space, aggression between individuals may result in shell damage, limb loss and even death. Some believe that the majority of this aggression is seen between males and females, so housing them as single-sex groups (usually males) appear to reduce the potential for problems. Sexual dimorphism is identifiable because males have narrow aprons, and when they molt into adults, the limbs with chelipeds become elongated.

It is also important that the aquarium exhibit space is large enough for the JSCs to successfully molt and to allow for sufficient distance between individuals to reduce potential intra-specific aggression. For molting, the crabs need ample space behind themselves so that they can extricate their bodies from their old exoskeleton. In some instances, if the crab reaches a barrier (rockwork, aquarium exhibit wall, or another crab) the process can be halted, causing molting problems ranging from limb deformities or loss to even death. As cessation of feeding is often a prelude to molting, it is sometimes possible to install a barrier in the aquarium exhibit to isolate the crab before it molts, ensuring that it has sufficient room to carry out the process and that other aquarium exhibit species will be unable to harm it.

Furnishing in a JSC exhibit can be non-existent. They will thrive given a simple gravel or sand substrate. If furnishings such as rockwork or fiberglass rock replicas are used, they should not take up exhibit volume required by the JSCs themselves. Exhibit depth should be greater than the height of the largest crab when standing upright in a normal alert, poised position. If the exhibit depth is less than the leg span of the largest JSC, it is expected that they will, from time to time, orientate themselves perpendicular to the floor of the exhibit and reach above the water's surface. While there are no reports of JSCs being able to climb out of shallow exhibits, the potential for this should not be ruled out entirely. At the very least, JSC legs reaching above the water's surface may snag on LSS equipment, so covers should be employed for shallow exhibits and holding aquarium exhibits.

**AZA Accreditation Standard**

**(10.3.3)** All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being; and exhibit enclosures must include provisions for the behavioral enrichment of the animals. AZA housing guidelines outlined in the Animal Care Manuals should be followed.

The same careful consideration regarding exhibit size and complexity and its relationship to the JSCs' overall well-being must be given to the design and size of all enclosures, including

those used in exhibits, holding areas, hospital, and quarantine/isolation (AZA Accreditation Standard 10.3.3). Sufficient shade must be provided by natural or artificial means when sunlight is likely to cause overheating or discomfort to the animals (AZA Accreditation Standard 10.3.4). Housing JSCs off-exhibit is generally for a shorter term for quarantine or isolation during molting. Any long-term off-exhibit housing should meet the requirements above. Nothing is known of the behavioral enrichment needs of this species, and environmental variability is not suggested if it exceeds the variation experienced in the wild, either by range or rate of change.

**AZA Accreditation Standard**

**(10.3.4)** When sunlight is likely to cause overheating of or discomfort to the animals, sufficient shade (in addition to shelter structures) must be provided by natural or artificial means to allow all animals kept outdoors to protect themselves from direct sunlight.

## 2.2 Safety and Containment

Exhibits in which the visiting public is not intended to have contact with animals, like the JSCs, must have a means for deterring public contact (AZA Accreditation Standard 11.3.6). Typically this is managed by housing JSCs in enclosed aquarium exhibits. JSCs should not be maintained in an exhibit that will allow the public to have contact with them as this species is too delicate to be exposed to handling by the general public.

**AZA Accreditation Standard**

**(11.3.6)** In areas where the public is not intended to have contact with animals, some means of deterring public contact with animals (e.g., guardrails/barriers) must be in place.

Animal exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). JSCs are usually maintained in aquarium exhibits with little furnishings or climbing areas. Since these crabs are not able to climb smooth vertical concrete or fiberglass walls, there is little chance of them crawling to the top of the aquarium exhibit. In exhibits where certain furnishings are used, or temporary barriers are in place (separating molting crabs), the surfaces may be rough enough that the crabs can gain purchase and then has the potential to climb to the surface. While it is unlikely that the crab will climb completely out of the display, a simple lid can be constructed and laid over the top of the exhibit to avoid any potential egress. Likewise, if the top of the aquarium exhibit is extended above the water vertically with a smooth surface, it would prevent the crab from being able to egress.

**AZA Accreditation Standard**

**(11.3.1)** All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

All emergency safety procedures must be clearly written, provided to appropriate staff and volunteers, and readily available for reference in the event of an actual emergency (AZA Accreditation Standard 11.2.4). The main threat to JSCs is loss of electrical power that would shut down the LSS. During various weather events that can cause an interruption of power, continue monitoring all LSS to make sure it is in correct working order. It is highly recommended that systems have backups (pumps, chillers, etc.) readily available in the event of either a mechanical breakdown or disaster. It is also recommended that LSS's are backed up with a working generator in case of long term power failure.

**AZA Accreditation Standard**

**(11.2.4)** All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

Staff training for emergencies must be undertaken and records of such training maintained. Security personnel must be trained to handle all emergencies in full accordance with the policies and procedures of the institution and in some cases, may be in charge of the respective emergency (AZA Accreditation Standard 11.6.2). Emergency drills should be conducted at least once annually for each basic type of emergency to ensure all staff is aware of emergency procedures and to identify potential problematic areas that may require adjustment. These drills should be recorded and evaluated to ensure that procedures are being followed, that staff training is effective and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills should be maintained and improvements in the procedures duly noted whenever such are identified (AZA Accreditation Standard 11.2.5). AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.6). AZA-accredited institutions must also ensure that written protocols

**AZA Accreditation Standard**

**(11.6.2)** Security personnel, whether staff of the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e. shooting teams).

define how and when local police or other emergency agencies are contacted and specify response times to emergencies (AZA Accreditation Standard 11.2.7).

AZA Accreditation Standard 10.2.1 mandates that warning mechanisms and back-up systems must be available for critical life support systems. With the strict temperature tolerances of JSC and their moderately high waste output, the chilling systems and pumps that maintain flow across the biofilter should be considered necessities and be tied to a backup generator or have the ability to be connected to emergency power quickly. As with most aquatic animals, if power or the LSS is compromised, feeding should cease until the system is restored to normal and the filtration can handle the additional input of organics to avoid catastrophic water quality degradation. In the event of a catastrophic loss of power that cannot be restored in the near future, rising floodwaters, or other similar situation that will result in the imminent death of a captive JSC if it cannot be relocated to adequate holding facilities, the institution should consider euthanasia to prevent protracted suffering of the animal. Techniques for euthanasia are discussed in Section 6.7.

In the event of an animal escape, the JSP is very slow moving and will not travel far. If found outside of an exhibit, lift the crab by holding onto the back of the carapace being careful of its pinchers as they can cause damage, and place back in the water. Rotate the animal upright while returning it to the water so that any air that may have become trapped in its gills will be expelled (termed "burping" by some aquarists).

Whenever diving or working with JSCs, it is important to be mindful of the proximity of their pinchers which they will use if feeling threatened. When working with JSCs in a manner where pinching may occur, the pinchers may be rubber banded together to prevent pinching (Figure 2). If the pinchers are not banded together, it is advisable to have a tool (pliers, leverage bar) that can be used to pry off a crab's pinchers. If pinched, try to relax and place the crab back in its normal environment. Usually the crab will release its grip on its own. If the crab will not release, simply place the tool in between the pinchers and forcefully open them. Rarely will the pinched area need any medical attention. If the skin is broken, take care of the wound with a first aid kit.

**AZA Accreditation Standard**

**(11.2.5)** Live-action emergency drills must be conducted at least once annually for each of the four basic types of emergency (fire; weather/environment appropriate to the region; injury to staff or a visitor; animal escape). Four separate drills are required. These drills must be recorded and evaluated to determine that procedures are being followed, that staff training is effective, and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills must be maintained and improvements in the procedures documented whenever such are identified.

**AZA Accreditation Standard**

**(11.2.6)** The institution must have a communication system that can be quickly accessed in case of an emergency.

**AZA Accreditation Standard**

**(11.2.7)** A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

**AZA Accreditation Standard**

**(10.2.1)** Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment must be kept in working order and should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

Figure 2. Japanese spider crab shipped damp from Japan. Note bound legs and damp moss adhering to shell.
Photo Credit: Jay Hemdal

# Chapter 3. Records

## 3.1 Definitions

In the zoo and aquarium world, animal records are defined as "data, regardless of physical form or medium, providing information about individual animals, samples or parts thereof, or groups of animals". Most animals in zoo and aquarium collections are referred to as individuals, though some types of animals are referred to as groups or colonies of animals, particularly with invertebrates and in aquariums (see Appendix B for definitions and Recordkeeping Guidelines for Group Accessions). The decision about how to record its animals usually resides with each institution, but in certain cases, the AZA Animal Program Leader (i.e., TAG Chair, SSP Coordinator, or studbook keeper) may request that animals be recorded in a certain manner, whether as individuals or as groups. In the case of JSCs, most aquariums house relatively few animals, which vary enough in morphology that individual accessions can be made. In larger aquariums, housing many animals, it may be elected to track this species as a group.

## 3.2 Types of Records

There are many types of records kept for the animals in our care, including but not limited to, veterinary, husbandry, behavior, enrichment, nutrition and collection management. These types of records may be kept as separate records as logs in separate locations or as part of the collection records and some may be required by regulating agencies (e.g., primate enrichment records as required by USDA Animal Welfare Act) or per AZA Accreditation Standards (e.g., emergency drill records).

Recordkeeping is an important element of animal care and ensures that information about individual animals or groups of animals is always available. These records contain important information about an individual animal or group of animals, including but not limited to taxonomic name, transaction history, parentage, identifiers, gender, weights, enclosure locations and moves, and reproductive status (see Appendix C for Guidelines for Creating and Sharing Animal and Collection Records). Many aquariums housing JSCs utilize, or will soon be using, the Zoological Information Management System (ZIMS), web-based software to manage their animal records. Aquariums utilizing other software will still want to manage the data concerning their JSCs in a similar fashion.

A designated staff member should be responsible for maintaining the animal recordkeeping system and for conveying relevant laws and regulations to the animal care staff (AZA Accreditation Standard 1.4.6). Recordkeeping must be accurate and documented on a daily basis (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal records must be duplicated and stored at a separate location (AZA Accreditation Standard 1.4.4) and historical records safely stored (AZA Accreditation Standard 1.4.5).

AZA member institutions must inventory their JSC population at least annually and document all JSC acquisitions, transfers, and transitions (AZA Accreditation Standard 1.4.1). All JSCs owned by an AZA institution must be listed on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2). All AZA-accredited institutions must abide by the AZA Policy on Responsible Population Management: Acquisitions, Transfers and Transitions by Zoos & Aquariums (ATT Policy) (see Appendix D) and the long-term welfare of animals should be considered in all acquisition, transfer, and

**AZA Accreditation Standard**

**(1.4.6)** A staff member must be designated as being responsible for the institution's animal recordkeeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all animal care staff members apprised of relevant laws and regulations regarding the institution's animals.

**AZA Accreditation Standard**

**(1.4.7)** Animal records must be kept current, and data must be logged daily.

**AZA Accreditation Standard**

**(1.4.4)** Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

**AZA Accreditation Standard**

**(1.4.5)** At least one set of the institution's historical animal records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

**AZA Accreditation Standard**

**(1.4.1)** An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions at the institution.

**AZA Accreditation Standard**

**(1.4.2)** All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution. In both cases, notations should be made on the inventory.

transition decisions. Specifically, JSCs are not suitable for transfer to the general public.

All transactions should be documented by the facility's accepted Animal Transaction Confirmation (ATC) form. Minimum data that should be maintained for JSCs include acquisition information such as date, source, permits required, shipping methods, etc.; position of the JSC in the facility's Institutional Collection Plan (how many animals are in the current collection, why they are in the collection, and the number projected for the collection); dates of molts; date of transitions; individual accession numbers; breeding activity; feeding activity; and all veterinary procedures performed on any JSCs in the collection (see Chapter 7, Section 1). Additional data that may be helpful include breeding activity logs, dietary logs, and images that are helpful in identifying animals.

## 3.3 Permit Considerations

Many of the species cooperatively managed through AZA's Animal Programs (i.e., TAGS, and SSPs) are regulated by federal and/or state governments. Therefore, possession and/or specific activities involving these species often require a permit(s) issued by the regulating agency, granting permission for possession and/or the specific activities. Depending on the agency involved, the application and approval process may take a few days to many months. These permits must be received by the applicant before the proposed possession or activity can occur. Currently, there are no known permits required to possess this species in North America. However, as all JSCs currently available are imported, and this should be conducted under the USFWS or Environment Canada's importation requirements.

## 3.4 Identification

Ensuring that JSCs are identifiable through various means increases the ability to care for individuals more effectively. All animals held at AZA facilities must be individually identifiable whenever practical, and have corresponding identification (ID) numbers. For animals maintained in colonies or groups, or other animals not considered readily identifiable, institutions must have a procedure for identification of and recording information about these groups or colonies. (AZA Accreditation Standard 1.4.3). These IDs should be included in specimen, collection and/or transaction records and veterinary records. Types of identifiers include:

**AZA Accreditation Standard**

**(1.4.3)** Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies/groups or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

Physical identifier: These include, but are not limited to, ear and/or wing tags, leg bands, tattoos, microchips/transponder and RFID devices, elastomers, ear and/or shell notches and toe clips. Permanent physical identifiers are often required when a species is regulated by a government agency and to distinguish separate animals in studbooks.

Intangible identifiers (called 'logical identifiers' in the Zoological Information Management System [ZIMS]): These include, but are not limited to, institutional accession number, house name, public name, studbook number, and ZIMS Global Accession Number.

All JSCs should be individually identified by the holding facility unless there are >25 animals in the aquarium exhibit, in which case group management may be more appropriate. In most instances, the staff can visually identify individuals, although digital photographs may aid the identification process. Since color patterns and size will change as the animals shed their exoskeletons, regular updates of these photographs will be necessary. Some aquariums have used simple external branding or banding techniques (e.g., cable ties of different colors attached to different legs) to identify animals, however, these markings require reapplication after each molting event. Invasive types of identification (e.g., coded wire tags, visible implant elastomers, and dactyl clipping) might prove longer-lasting, but any breach of a crab's shell is not recommended.

# Chapter 4. Transport

## 4.1 Preparations

> **AZA Accreditation Standard**
>
> **(1.5.11)** Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to.

Animal transportation must be conducted in a manner that adheres to all laws, is safe, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11). All temporary, seasonal, and traveling live animal exhibits must meet the same accreditation standards as the institution's permanent resident animals (AZA Accreditation Standard 1.5.10). Safe animal transport requires the use of appropriate conveyance and equipment that is in good working order. Include copies of appropriate permits and authorizations in transport documentation. If the animal is not owned by the shipping institution, permission is to be obtained from the owner well in advance of the move.

Heavy duty shipping bags of a minimum of three to four mils should be used to minimize tearing or puncture. Double or even triple bagging the animal is a good failsafe in the event of a faulty or damaged bag. In some instances, JSCs are shipped in moss soaked in seawater, but the general recommendation is to ship them in seawater with sufficient depth to cover their gills. Newspaper may be placed in between bags to absorb condensation or minor leaks. Styrofoam boxes and cardboard shells should be checked for damage prior to shipping. The ideal shipping box should not be too small which may apply pressure to the crab's body, but it should also not be too large, which may allow the crab to jostle during shipment and also injure the crab.

> **AZA Accreditation Standard**
>
> **(1.5.10)** Temporary, seasonal and traveling live animal exhibits (regardless of ownership or contractual arrangements) must meet the same accreditation standards as the institution's permanent resident animals.

The equipment must provide for the adequate containment, acceptable water quality parameters, life support, comfort, temperature control, and safety of the JSC(s). Care should be taken to ensure the temperature in the transport vessel remains within acceptable range (see Chapter 1 for ideal parameters). This can be accomplished using an appropriately sized insulated box or cooler, ice packs, chillers (for in-house or long distance ground transfer), etc. Considerations should be made for the amount of time the transport will take and the ambient air temperature or local climate. A mock transport using data loggers will help determine the number of ice packs to be placed within a Styrofoam shipping box.

JSCs have no feeding or lighting requirements during transport. Although dry shipping is sometime practiced, the AZA Aquatic Invertebrate TAG recommends that JSCs be shipped in water to minimize stress on the animal. Water quality during transport should remain within acceptable parameters (see Chapter 1), Long-distance shipping events (18–24 hours) will result in some degradation of water quality however, the following steps may minimize negative effects:

- Fast crabs for a minimum of two to four days prior to transport
- Saturate the shipping water with dissolved oxygen
- Use sodium bicarbonate to buffer the water to minimize pH drop
- Use a detoxifying agent, such as AmQuel, to bind ammonia

See section 7.5 for specific information regarding capture, restraint, and immobilization of JSCs. Shipping boxes should be labeled with warning labels to signify live animal transport, fragile, keep upright, and any ambient temperature requests. Only one adult crab should be shipped per shipping box to avoid the possibility being stressed by the presence of other adults in such close quarters. Multiple juvenile crabs can be shipped in one box, but they should be bagged separately. Crabs do not need vet access during transport nor do they need medication for relaxation.

Prior to adding the crab to a new system of water, carefully match the water parameters such as temperature, pH and salinity as closely as possible with what the animal is accustomed to using an appropriate acclimation method. It is important to remember that ammonia is much more toxic to aquatic animals than ammonium ion is. During acclimation, the pH of the shipping water is depressed, changing most of the total ammonia to non-toxic ammonium. As system water is added to the shipping water, and carbon dioxide off-gasses, the pH will quickly rise, faster than the ammonium is being diluted. This changes the ammonium back to ammonia, harming the animals. One workaround that aquarists rely on is to immediately move the animal to be acclimated into water that has exactly the same pH and salinity as

the shipping water (but minus the ammonia). Then, acclimation can proceed slowly, without fear of ammonia toxicity. The following chart may help estimate the percentage of ammonia under different conditions (Table 3).

Table 3. % Percent of ammonia from 'total ammonia'

| Temp °C (°F) | pH 6.5 | pH 7.0 | pH 7.5 | pH 7.7 | pH 8.0 | pH 8.5 |
|---|---|---|---|---|---|---|
| **20 °C (68 °F)** | 0.125 | 0.395 | 1.239 | 1.95 | 3.81 | 11.15 |
| **25 °C (77 °F)** | 0.179 | 0.565 | 1.766 | 2.77 | 5.380 | 15.242 |
| **28 °C (82 °F)** | 0.221 | 0.696 | 2.170 | 3.396 | 6.55 | 18.156 |
| **30 °C (86 °F)** | 0.253 | 0.798 | 2.482 | 3.78 | 7.450 | 20.292 |

## 4.2 Protocols

Transport protocols should be well defined and clear to all animal care staff. Safe acquisition and transport also requires the assignment of an adequate number of appropriately trained personnel who are equipped and prepared to handle contingencies and/or emergencies that may occur. Planning and coordination for animal transport requires good communication among all affected parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger (AZA Accreditation Standard 1.5.11).

# Chapter 5. Social Environment

## 5.1 Group Structure and Size

Careful consideration should be given to ensure that animal group structures and sizes meet the social, physical, and psychological well-being of those animals and facilitate species-appropriate behaviors. The recommended social structure for JSCs is an all-male or all-female group, primarily in order to prevent mating stress, which can lead to aggression, loss of limbs, lack of appetite, or death. The size of the group is dependent upon the size of the aquarium exhibit (see section 2.1 for further information).

## 5.2 Influence of Others and Conspecifics

Animals cared for by AZA-accredited institutions are often found residing with conspecifics, but may also be found residing with animals of other species. JSCs co-habitat well with a variety of fish and invertebrates. These include bony fish such as snipefish (*Macroramphosus gracilis*), and invertebrates including echinoderms, anemones and other crabs (e.g., Alaskan king crabs (*Paralithodes camtschaticus*) and California king crabs (*Paralithodes californiensis*)).

Cabezon (*Scorpaenichthys marmoratus*) have been noted as an inappropriate species for JSCs to share an aquarium exhibit with as they have been known to nip at the aprons of the crabs and, in some cases, tear aprons off, causing a great deal of stress to the crab. In some cases, larger fish (such as bocaccio [*Sebastes paucispinis*] and Pacific cod [*Gadus macrocephalus*]) have been seen stealing food items from the crabs which then causes the crab to stop eating and reject any other food offered that day. Generally, these animals tend to occupy different layers in the exhibit, staying out of each other's way, and negative interactions only occur during feeding.

Typical interactions between conspecifics are generally positive however JSCs may show aggression during mating and sometimes during feeding. One aquarium has seen an unusual aggression pattern whereby JSCs who successfully co-habitated with sea stars, *Bathynomus* isopods, *Paralomis* crabs and sea anemones for times ranging from months to over a year, suddenly ate these animals on four separate instances. With the *Paralomis* crabs, it is possible that the change from interpreting the species as a co-habitant to prey was precipitated by impending molting (see section 7.4). In the other cases, no forewarning was given of the impending attack by the JSCs.

Exhibit design for mixed species groups should take several things into consideration. For example, making the exhibit deep enough that the animals can occupy different layers in the exhibit will make the animals comfortable and the exhibit look dynamic. Inserts, or other things for crabs/fish to crawl/perch on, will create more surface area for resting. The exhibit will need to be large enough for baskets or barriers to be added when introducing or separating animals, especially when considering an isolation area for molting crabs. It may be a good idea to design a special alcove or another area where crabs can be placed while molting in order to keep them in the same aquarium exhibit water throughout the whole process. Additionally, the exhibit should be designed with enough bottom area to accommodate all animals comfortably.

## 5.3 Introductions and Reintroductions

Managed care for and reproduction of animals housed in AZA-accredited institutions are dynamic processes. Animals moved between and within institutions require introduction and sometimes reintroductions to other animals. It is important that all introductions are conducted in a manner that is safe for all animals and humans involved.

Anytime a JSC is introduced into the water, care should be taken to always "burp" the crab to remove any air pockets that formed under the carapace near the gills. This can be accomplished by gently rotating the crab underwater in all directions until no further air bubbles escape. The timing of releasing the crab into its new holding aquarium exhibit doesn't seem to matter, but if possible, it is recommended to keep the introduced or reintroduced crab separated from others for a few days so it can adapt to its new surroundings and co-habitants. It is recommended that acrylic barriers be used for this purpose as they can also be used to separate potential and currently molting crabs (see section 5.2). Large floating baskets (made from plastic mesh—Nitex or Conwed) have been used as well, but occasionally a crab will try to climb out of them and could potentially harm itself. Introducing young crabs to adult groups should

not pose significant problems as there does not seem to be a dominance hierarchy, and new introductions generally go smoothly.

Before introducing new crabs into an aquarium exhibit, an initial veterinary examination should be performed including evaluation for “black spot disease” (see section 7.4 for further information). Crabs should also be banded for identification (e.g., colored zip ties or aquaculture tags).

# Chapter 6. Nutrition

## 6.1 Nutritional Requirements

> **AZA Accreditation Standard**
>
> **(2.6.2)** The institution should have a written nutrition program that meets the behavioral and nutritional needs of all species, individuals, and colonies/groups in the institution. Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs.

A formal nutrition program is recommended to meet the nutritional and behavioral needs of all species (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the Nutrition Scientific Advisory Group (NAG) feeding guidelines: (http://www.nagonline.net/Feeding%20Guidelines/feeding_guidelines.htm), and veterinarians as well as AZA Taxon Advisory Groups (TAGs), and Species Survival Plan® (SSP) Programs. Diet formulation criteria should address the animal's nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

Popular literature suggests that JSCs are opportunistic scavengers, feeding on animal and plant matter. Experience with these crabs in ex situ conditions supports this conclusion. There seems to be some underlying motivation for the crabs to feed on one item versus another. For example, many aquariums have reported that their crabs would actively feed on algae or gel diet initially, but then reduce their feeding response after a few weeks. It may be that the novelty of the food items simply wears off. If this is the case, then a rotating choice of diets may prove beneficial. The need for vitamin and mineral supplementation has not been identified by scientific diet analysis, but many aquariums supplement food items as a general rule, notably vitamin E and thiamin.

## 6.2 Diets

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the animal's psychological and behavioral needs (AZA Accreditation Standard 2.6.2). Food should be purchased from reliable, sustainable and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

Appendix F lists the diets and feeding schedules offered to JSCs by survey respondents. There is no indication of a seasonal nature of JSC diets. The diet they are fed is composed of menu items already available for feeding other animals in most aquariums. The following is a feeding account from one public aquarist:

> "Our crabs' diet is varied daily in amount and type of food offered. We offer 25 to 50 grams (0.88 to 1.76 ounces) of food per crab, five to six times per week and they will typically eat everything that is offered with the exception of large (>40 g [1.4 oz.]) squid in which case they'll eat about half. Their diet over the past two years has consisted primarily of capelin, squid, shrimp and clam. Shrimp and clam seem to be particularly relished. Shrimp is typically fed with the shell still on so that the crabs might benefit from the calcium and other mineral content of the shells. Other types of fish such as mackerel, herring and sardine are occasionally offered, but less often as these oily and/or bloody fish have a greater deleterious effect on the water quality of our modest display of approximately 600 gallons (2300 liters). In an attempt to provide plant matter, nori (food grade algae sheets) has been offered. Our crabs were very interested in nori the first time it was offered and were observed attaching the nori to the backs of their exoskeletons. Most of the nori was eaten, however, subsequent offerings of nori were met with diminishing interest and greater amounts of left over uneaten food. A variety of herbivorous and omnivorous gel foods have also been offered, but with little success. It might also be worth noting that when our second crab molted, the crab was not removed promptly enough and the other crab pulled one of its legs off and was found the next morning eating the leg. So, apparently, spider crabs can also be cannibalistic. The food items that we have offered to our JSCs has been limited primarily to what is convenient and already in our stores and to those food items which are apt to provide the most nutrition with the least impact on water quality. Our experience suggests that there are many other food items that could be used to feed these crabs. Ultimately, all we can say about our nutrition regime is that we have cared for these animals for almost two years, with zero mortalities, through an outbreak of blackspot disease and through two successful molts (though

one did not re-grow a leg and one lost a leg) and they appear to be in excellent health with normal appetites."

JSC are normally fed using a broadcast feeding method (i.e., providing food to all animals simultaneously), so that each animal is able to secure a feed item at roughly the same time, thereby reducing competition between animals. Stick feeding is also an option, however in most instances, this is performed by a single aquarist, so there is a delay in offering food from one animal to the next which can increase competition and the incidence of food stealing. The JSC survey indicates that feeding frequency varies between institutions, ranging from once per week to five times per week. 70% of the respondents feed their JSC three to five days per week. No aquarium feeds on a daily basis (e.g. seven days per week).

**AZA Accreditation Standard**

**(2.6.1)** Animal food preparation and storage must meet all applicable laws and/or regulations.

Food preparation must be performed in accordance with all relevant federal, state, or local laws and/or regulations (AZA Accreditation Standard 2.6.1). Meat processed on site must be processed following all USDA standards. The appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for your species specified. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise and dispose of per USDA guidelines.

## 6.3 Nutritional Evaluations

There are no known health problems in JSCs that can positively be directly linked to the diet offered them in aquariums. Additionally, there is no available list of tools and methods that can be used to evaluate the body condition of JSCs.

# Chapter 7. Veterinary Care

## 7.1 Veterinary Services

Veterinary services are a vital component of excellent animal care practices. A full-time staff veterinarian is recommended, however, in cases where this is not practical, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and to any emergencies (AZA Accreditation Standard 2.1.1). In some instances, because of their size or nature, exceptions may be made to the twice-monthly inspection requirement for certain institutions (e.g., insects only, etc.). Veterinary coverage must also be available at all times so that any indications of disease, injury, or stress may be responded to in a timely manner (AZA Accreditation Standard 2.1.2). The AZA Accreditation Standards recommend that AZA-accredited institutions adopt the guidelines for medical programs developed by the American Association of Zoo Veterinarians (AAZV) (http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839).

**AZA Accreditation Standard**

**(2.1.1)** A full-time staff veterinarian is recommended. In cases where such is not practical, a consulting/part-time veterinarian must be under written contract to make at least twice monthly inspections of the animals and to respond as soon as possible to any emergencies.

**AZA Accreditation Standard**

**(2.1.2)** So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animals 24 hours a day, 7 days a week.

The current list of Aquatic Invertebrate TAG advisors (including veterinary advisors) can be found via the AZA Animal Program page, however little is known about the medical needs of JSCs. Protocols for assessing JSC health should include at least once daily visual inspection of all crabs in the institution's care, as well as the monitoring of each crab's food intake. Those seeking additional veterinary resources for JSCs are urged to review "Invertebrate Medicine" (Lewbart, 2012), although this publication does not contain information specific to JSCs. Oftentimes, additional information may be garnered from researchers working in the crustacean food- related industry (e.g., lobster culture).

Protocols for the use and security of drugs used for veterinary purposes must be formally written and available to animal care staff (AZA Accreditation Standard 2.2.1). Procedures should include, but are not limited to: a list of persons authorized to administer animal drugs, situations in which they are to be utilized, location of animal drugs and those persons with access to them, and emergency procedures in the event of accidental human exposure. There is no comprehensive list of drugs used for JSCs, but various types of gram-negative antibiotics might be used to control various issues in these animals. Any prescription medications should be utilized under the supervision of a veterinarian.

**AZA Accreditation Standard**

**(2.2.1)** Written, formal procedures must be available to the animal care staff for the use of animal drugs for veterinary purposes, and appropriate security of the drugs must be provided.

Veterinary recordkeeping is an important element of animal care and ensures that information about individual animals and their treatment is always available. A designated staff member should be responsible for maintaining accurate animal veterinary record keeping. Record keeping information regarding specific JSC for veterinary care is at the discretion of the facility, however the Aquatic Invertebrate TAG recommends that the following data be consistently recorded:

- Water temperature, pH, & salinity.
- Food intake
- Molting dates

There are no specific JSC health-related record-keeping regulations known in the United States and they are not regulated by CITES, the ESA or the USDA. Some states may require veterinary health inspections prior to moving a JSC from one state to another as a result of laws and regulations already in place to govern seafood items, that also apply to JSC used for displays.

## 7.2 Transfer Examination and Diagnostic Testing Recommendations

The transfer of animals between AZA-accredited institutions or certified related facilities due to AZA Animal Program recommendations occurs often as part of a concerted effort to preserve these species. These transfers should be done as altruistically as possible and the costs associated with specific examination and diagnostic testing for determining the health of these animals should be considered.

Since JSCs have not yet propagated in aquarium exhibits, inter-facility transfers are made only for demographic reasons. Pre-shipment examinations can be performed by a veterinarian, although this is not required because JSC-specific diagnostic tests or baseline hemolymph (blood) values are not established for this species. Typically, a visual exam is performed to note body/shell condition and assess for black spot disease.

JSCs arriving from the wild occasionally have epithetic organisms attached including hydroids and stalked barnacles. These commensal organisms do not seem to cause any health issues with JSCs. A parasitic barnacle, *Sacculina* sp., is more invasive and has been shown to cause health problems in portunid crabs, however its presence on JSCs has not been observed to date.

## 7.3 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals (AZA Accreditation Standard 2.7.1). All quarantine, hospital, and isolation areas should be in compliance with AZA standards/guidelines (AZA Accreditation Standard 2.7.3; Appendix E). All quarantine procedures should be supervised by a veterinarian, formally written and available to staff working with quarantined animals (AZA Accreditation Standard 2.7.2). If a specific quarantine facility is not present, then newly acquired animals should be kept separate from the established collection to prohibit physical contact, prevent disease transmission, and avoid aerosol and drainage contamination. If the receiving institution lacks appropriate facilities for quarantine, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applicable. Local, state, or federal regulations that are more stringent than AZA Standards and recommendation have precedence.

**AZA Accreditation Standard**

**(2.7.1)** The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals.

**AZA Accreditation Standard**

**(2.7.3)** Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals* developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: http://www.aazv.org/associations/6442/files/veterinary_standards_2009_final.docx.

**AZA Accreditation Standard**

**(2.7.2)** Written, formal procedures for quarantine must be available and familiar to all staff working with quarantined animals.

Quarantine should last a minimum of 30 days (unless otherwise directed by the staff veterinarian. Newly acquired JSCs should be quarantined in a dedicated aquarium exhibit to mitigate risk of disease transfer. If additional JSCs or other invertebrates are introduced into their corresponding quarantine areas, the minimum quarantine period should begin over again. If JSCs are moved from their aquarium exhibit, but not exposed to water from a different LSS, there is then no assumed risk of infectious agents returning with them to the facility. If however, they are exposed to a different LSS, risk is involved, and may require remediation up to and including re-quarantining of the JSC before its return to its original aquarium exhibit.

Care should be taken to prevent cross-contamination between the JSC aquarium exhibit and other aquarium exhibits, especially if there has been any previous indication of health issues. A new JSC should only be placed in an aquarium exhibit formerly occupied by a conspecific that has died if the death was clearly the result of a natural process (i.e. senescence). If the reason for death is unknown, the aquarium exhibit should remain empty until veterinary staff have completed pathology work to rule out an infectious process or until the aquarium exhibit is chemically disinfected and the water is re-cycled. It is not recommended to add newly imported JSCs directly to an exhibit housing post-quarantine animals.

If aquarists must care for both quarantined and resident animals of the same class, they should care for the quarantined animals only after caring for the non-quarantined animals. Care should be taken to ensure that these aquarists are “decontaminated” before caring for the non-quarantined animals again.

Equipment used to feed, care for, and enrich animals in quarantine should be used only with these animals. If this is not possible, then all items must be appropriately disinfected, as designated by the veterinarian supervising quarantine before use with non-quarantined animals. If the facility does not have a standard disinfection procedure, a simple one is to make a chlorine/water solution with a ratio of 1:10 tap water and bleach. (5% sodium hypochlorite with no dyes or perfumes). Aquarium exhibit tools should remain in the disinfectant dip solution for ten minutes, rinsed well in tap water and hung to dry. The dip

solution should be changed bimonthly. Another procedure is to have dedicated aquarium exhibit tools available for each water system at the facility.

AZA institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases (AZA Accreditation Standard 11.1.2) with all animals, including those newly acquired in quarantine. JSC possess no known species-specific zoonotic danger to humans. However, all aquaria have the potential to harbor and transmit bacterial diseases to humans, including *Mycobacterium* species. Towards this end, aquarists are advised to wear gloves when handling this species. Because latex gloves can easily snag of the shells of JSCs, it is a better option to choose gloves made of sturdier material.

**AZA Accreditation Standard**

**(11.1.2)** Training and procedures must be in place regarding zoonotic diseases.

If an animal should die in quarantine, a necropsy should be performed on it and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standard 2.5.1). If the animal is on loan from another facility, the loan agreement should be consulted as to the owner's wishes for disposition of the carcass; if nothing is stated, the owner should be consulted. Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination (see section 7.6).

**AZA Accreditation Standard**

**(2.5.1)** Deceased animals should be necropsied to determine the cause of death. Cadavers must be stored in a dedicated storage area. Disposal after necropsy must be done in accordance with local/federal laws.

## 7.4 Preventive Medicine

AZA-accredited institutions should have an extensive veterinary program that must emphasize disease prevention (AZA Accreditation Standard 2.4.1). The American Association of Zoo Veterinarians (AAZV) has developed an outline of an effective preventative veterinary medicine program that should be implemented to ensure proactive veterinary care for all animals: (www.aazv.org/associations/6442/files/zoo_aquarium_vet_med_guidelines.pdf).

**AZA Accreditation Standard**

**(2.4.1)** The veterinary care program must emphasize disease prevention.

Very little is known about preventative medical practices with JSCs, and no published veterinary references specific to this species are available. Aquarists provide most of the medical support offered to JSCs via husbandry management rather than veterinary medicine, although a veterinarian should interpret any lab results and determine the best course of action for preventing disease. As stated in section 7.1, some overall information may be extrapolated from crustacean medicine, but as always, this entails some risk of misapplication of information.

The most prominent physiological challenge for JSC is their molting process, or ecdysis. The onset of molting is typically predicated by the animal's refusal to feed. When a crab refuses food for three consecutive feeds, it may be ready to molt. The actual shedding of the exoskeleton (exuviations) may take only 20 to 45 minutes. Once the exoskeleton has been shed, the JSC has an extremely soft new shell which leaves the animal vulnerable to predation until it hardens. This hardening typically occurs within seven days. It is recommended that a clear acrylic barrier can be inserted into the aquarium exhibit to separate the crab from rest of the animals before, during, and after molting so that the animal is kept safe from predators. When the crab starts to accept food again, it can be assumed that the shell has hardened, and the barrier can be removed.

Black spot shell disease, which is actually considered likely to be a symptom, and not actually a disease, is another common physiological challenge with JSCs. It is generally thought that various environmental stressors can contribute to symptoms (Tlusty, 2007 in Lewbart, 2012) that typically manifests themselves as pitting lesions and erosion areas to the shell, causing dark, sometimes black, spots. Lesions that penetrate to the internal portion of the JSC are extremely serious. A wide variety of organisms can be isolated from these lesions including protozoans, bacteria and fungus.

Air entrapment or "failure to burp" occurs when air becomes trapped in the JSC's gill chamber, thereby drying out the gills and causing asphyxiation. Air entrapment typically occurs when the JSC is removed from the water (Lewbart, 2012). To prevent this from happening, it is important for the aquarist to hold the JSC in a head-down position and then carefully turn the animal upright and slightly onto their backs to allow any trapped air to be released.

Mating stress is an additional challenge that has been identified for some JSCs. Male competition or mating practices can result in loss of limb and/or shell damage, which can lead to black spot lesions. The primary way to avoid this potential problem is to maintain same-sex groups.

Maintaining the appropriate water quality parameters with JSCs is very important, as this species are more sensitive to changes in water quality than fishes. Crustaceans are osmoconformers, typically maintaining internal salt levels similar to the salinity of their environment. They are intolerant of the unnaturally low salinities typical of some marine fish aquarium exhibits and also dislike rapid changes in salt level. JSCs are also susceptible to gas supersaturation like fish (Lewbart, 2012). To prevent this from occurring, utilize a LSS that does not have, or minimizes, the capacity to cause gas supersaturation episodes. If gas supersaturation does occur, aerate the water heavily. Crustacean water should be free of ammonia and nitrite, and nitrates should be kept below 20 mg/L (Mohan, 2007). To prevent water-quality related issues from occurring with JSCs, it is recommended that water quality parameters be maintained in a similar fashion as those found in a reef aquarium exhibit. Good husbandry practices are crucial, and water quality should be maintained by best practices.

A tuberculin testing and surveillance program must be established for animal care staff, as appropriate, to protect the health of both staff and animals (AZA Accreditation Standard 11.1.3). Aquarists working with JSCs have no known need for TB testing, and there are no vaccination protocols or regulations pertaining to JSCs. However, exposure to *Mycobacterium marinum*, a ubiquitous marine bacteria, may cause false-positive results on a standard tuberculin skin test in humans. Should any aquarist receive a positive TB skin test, they should ask their physician for follow-up testing with a more accurate diagnostic method to rule out true human TB.

**AZA Accreditation Standard**

**(11.1.3)** A tuberculin (TB) testing/surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animals. Each institution must have an employee occupational health and safety program.

## 7.5 Capture, Restraint, and Immobilization

The need for capturing, restraining and/or immobilizing a JSC for normal or emergency husbandry procedures may be required. All capture equipment must be in good working order and available to authorized and trained animal care staff at all times (AZA Accreditation Standard 2.3.1). In almost all cases, JSCs are carefully captured by hand with one or two aquarists.

**AZA Accreditation Standard**

**(2.3.1)** Capture equipment must be in good working order and available to authorized, trained personnel at all times.

Care should be taken to avoid pulling or grabbing the crab's legs or claws to manipulate it into position to be handled. If the crab is in a deeper body of water getting into the aquarium exhibit by diving or snorkeling may be the best option. Carefully bring the crab to the surface by handling it by the back of the carapace while it is underwater. This species is not known to be overly aggressive so it is not necessary to bind the chelipeds prior to handling. Before removing from the water, the crab should be inverted with its carapace down and limbs supported prior to lifting from the water. Smaller crabs can often be removed from the aquarium exhibit by one person, larger crabs typically need to be handled by two persons or may require a stretcher or wide net to adequately and evenly support the limbs. Once the crab is placed in the intermediate transport container or shipping bag, care should be taken to remove all air from underneath the carapace and from within the gills (see section 7.4).

JSC legs and claws can be restrained with rubber bands to prevent the animal from harming itself or from puncturing the shipping bags, particularly during long-distance transports (Figure 2). A minimum of two people, wearing protective gloves, should be involved in restraining the crabs legs and claws to avoid injury to the crab or themselves. A variety of rubber band sizes should be used, small ones to restrain the chelipeds, and larger ones to restrain the legs close to the body. These rubber bands should be tight enough to prevent flailing of the legs and claws but not too tight so that they will damage the shell or restrict circulation. Small pieces of soft foam may also be placed over the sharper points of the shell and the tips of the legs to avoid bag puncture.

If the crab is to be transferred for a short distance out of water, a minimum of two people should be used to carry the crab, ensuring that the limbs are cradled to prevent stress at the leg joints. Improper handling or failure to evenly support the crab's limbs during transport can lead to the limbs separating at the joints. Whether large or small, the crab should be moved with their carapace facing down as they are unable to support their body weight on their legs outside of the water.

## 7.6 Management of Diseases, Disorders, Injuries and/or Isolation

AZA-accredited institutions should have an extensive veterinary program that manages animal diseases, disorders, or injuries. Most institutions have the ability to isolate terrestrial animals in a hospital setting for treatment if necessary, however few aquaria have multiple large aquarium exhibit systems capable of holding JSCs in isolation for treatment if need be. In these instances, arrangements should be made to isolate the JSC(s) within the existing aquarium habitat using a divider. Typically, this divider is made of solid panel, a panel with holes, or a netted frame structure although some have reported that JSCs have tried to climb the netted divider.

Proactive management of JSCs just prior to, during and immediately after molting is extremely important. Aquarists should be sure that all JSCs are provided a proper diet, an aquarium exhibit that has the appropriate substrate, furnishings, and compatible aquarium exhibit species, and water that is maintained within the recommended quality and temperature ranges to provide the best environment for molting to be successful.

The most commonly reported cause of remission of black spot shell disease is reported to occur when a JSC molts and the lesions in the new shell are either reduced, or have disappeared entirely, however, it has also been reported that black spot lesions can become so severe that they interfere with the molting process itself (Lewbert, 2012). If noted, photographs of the animal should be taken routinely to monitor and track progression of the lesions. While there does not seem to be one particularly successful treatment for black spot shell disease beyond the naturally occurring molting process, a list of treatment methods utilized by different aquaria are listed below. This information is meant to serve as a starting point for additional research, as none of these methods has proven effective in all cases or resulted in a permanent solution to the issue.

- Various methods of disinfection and lesion sealing have been tried at one aquarium, but no lasting benefits were observed.
- Some speculate that increasing water flow pressure will keep shells cleaner which could result in a solution.
- Increase the calcium in the water and supplement the crab(s) with vitamin C.
- Lower the water temperature 2 °C (3.6 °F).
- Scrub the crabs' shell with a soft brush on a weekly basis.
- Inject feeder capelin with Amikacin and florfenicol for the crab to consume. This seemed to halt the problem, but should not be attempted without the instruction of a veterinarian, as dosages have not been worked out.
- Remove the crab from the water to give it an enrofloxicin bath (at 2 mg/L) and swab lesions with various antiseptics.
- Remove the crab from the water to flush the lesion(s) with a Nolvasan and saline solution, then dry and apply 22.7 mg/mL of enrofloxacin into the cavity of the lesion, seal the lesion(s) with dental cement. The crab tolerated this procedure well, however if the animal did not molt soon after, the cement would drop off and the lesion would return.

JSC aquarists should be trained for meeting the animal's dietary, husbandry, and enrichment needs, as well as in restraint techniques, and recognizing behavioral indicators animals may display if their health becomes compromised (AZA Accreditation Standard 2.4.2). Protocols should be established for reporting these observations to the veterinary department. In almost all instances, management of disease in JSCs takes place in an aquarium exhibit setting, not a hospital. Aquarists typically use food intake as a measure of overall health in JSCs. Relative activity, although very subjective, can also be an important diagnostic tool. Any deviation from the norm should be brought to the attention of the health care staff of the facility.

AZA-accredited institutions must have a clear process for identifying and addressing JSC animal welfare concerns within the institution (AZA Accreditation Standard 1.5.8) and should have an established Institutional Animal Welfare Committee. This

**AZA Accreditation Standard**

**(2.4.2)** Keepers should be trained to recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, keepers should not diagnose illnesses nor prescribe treatment.

**AZA Accreditation Standard**

**(1.5.8)** The institution must develop a clear process for identifying, communicating, and addressing animal welfare concerns within the institution in a timely manner, and without retribution.

process should identify the protocols needed for animal care staff members to communicate animal welfare questions or concerns to their supervisors, their Institutional Animal Welfare Committee or if necessary, the AZA Animal Welfare Committee. Protocols should be in place to document the training of staff about animal welfare issues, identification of any animal welfare issues, coordination and implementation of appropriate responses to these issues, evaluation (and adjustment of these responses if necessary) of the outcome of these responses, and the dissemination of the knowledge gained from these issues. AZA-accredited zoos and aquariums provide superior daily care and husbandry routines, high quality diets, and regular veterinary care, to support JSC longevity, however at present, there are no science-based metrics that have been developed to quantify welfare issues with JSCs.

As shown in Appendix F, common causes of JSC death include injury, secondary shell infections, failure to molt, and loss during transport. In the occurrence of the death of a JSC, information obtained from necropsies should be added to an in-house database of information that assists staff veterinarians to enhance the lives of JSCs both in their care and in the wild. Histopathology samples should be entered into this database for any JSC death. By way of example, the histopathology report of a JSC having black spot disease provided the following results:

> "Several sections of carapace had superficial areas of erosion with accumulation of frayed, deeply basophilic acellular material admixed with numerous filamentous and elongate bacteria. In other areas beneath the chitinous layer, there were large accumulations of brightly eosinophilic necrotic cell debris, numerous hemocytes and granulocytes with scattered phagocytic cells. Admixed with the necrotic cell debris, there were numerous fine bacterial colonies and fungal hyphae. These fungi were approximately 3–5 µm in diameter, were sparsely septate, and nonbranching. Within the overlying chitin, there were numerous similar fungal hyphae. Samples of skeletal muscle and coelom had multifocal areas of edema and mild infiltrates of granulocytes and fewer histiocytic cells."

The American Association of Zoo Veterinarians (AAZV) website and should be checked for any JSC research requests that could be filled from the necropsy. The subsequent disposal of any JSC carcasses must be done in accordance with local, state, or federal laws (AZA Accreditation Standard 2.5.1). If the animal was on loan from another facility, the loan agreement should be consulted as to the owner's wishes for disposition of the carcass; if nothing is stated, the owner should be consulted.

**AZA Accreditation Standard**

**(2.5.1)** Deceased animals should be necropsied to determine the cause of death. Cadavers must be stored in a dedicated storage area. Disposal after necropsy must be done in accordance with local/federal laws.

If euthanasia is required, the AAZV recommends the use of tricaine methanesulfonate (MS-222) however doses that exceeded 1 g/gal were shown to be ineffective. The AAZV also recommends the uses of isoflurane, clove oil (0.125 ml/L) or injecting KCl (100 mg/100 g) into the animal's hemolymph. Another process, recommended by a veterinarian is to administer an intracoelomic injection of a euthanasia solution (Beuthanasia-D 5 ml). After sedation, the JSC can be frozen as a secondary surety method.

# Chapter 8. Reproduction

## 8.1 Reproductive Physiology and Behavior

It is important to have a comprehensive understanding of the reproductive physiology and behaviors of the animals in our care. This knowledge facilitates all aspects of reproduction, artificial insemination, birthing, rearing, and even contraception efforts that AZA-accredited zoos and aquariums strive to achieve. Very little, however, is known about reproduction in JSCs. Male JSC are attracted to females after they molt, and have been observed fighting with other males in aquarium exhibits while in the presence of females. It is not known if these behaviors are also present in their natural ranges. Some aquariums preferentially acquire only male JSC to reduce this aggression.

## 8.2 Pregnancy, Egg-laying, and Larval Rearing

The female JSC incubates externally fertilized eggs inside her apron structure however to date, the zoea larval growth has not been successful. Decapod culture is difficult for most species, and specific techniques are unknown for JSCs. More information on the larval stages of this species can be found in Tanse, H. (1967). Video recordings of a female JSC incubating eggs, as well as of the zoea larvae can be found at: https://www.youtube.com/watch?v=ghjjLZ5JWBU.

# Chapter 9. Behavior Management

## 9.1 Animal Training

Classical and operant conditioning techniques have been used to train animals for over a century. Classical conditioning is a form of associative learning demonstrated by Ivan Pavlov. Classical conditioning involves the presentation of a neutral stimulus that will be conditioned (CS) along with an unconditioned stimulus (US) that evokes an innate, often reflexive, response. If the CS and the US are repeatedly paired, eventually the two stimuli become associated and the animal will begin to produce a conditioned behavioral response to the CS.

Operant conditioning uses the consequences of a behavior to modify the occurrence and form of that behavior. Reinforcement and punishment are the core tools of operant conditioning. Positive reinforcement occurs when a behavior is followed by a favorable stimulus to increase the frequency of that behavior. Negative reinforcement occurs when a behavior is followed by the removal of an aversive stimulus to also increase the frequency of that behavior. Positive punishment occurs when a behavior is followed by an aversive stimulus to decrease the frequency of that behavior. Negative punishment occurs when a behavior is followed by the removal of a favorable stimulus also to decrease the frequency of that behavior. To date, no facility has reported undertaking any training or conditioning procedures with JSCs.

## 9.2 Environmental Enrichment

Environmental enrichment, also called behavioral enrichment, refers to the practice of providing a variety of stimuli to the animal's environment, or changing the environment itself to increase physical activity, stimulate cognition, and promote natural behaviors. Stimuli, including natural and artificial objects are presented in a safe way for the JSCs to interact with. Enrichment programs for JSCs should take into account the natural history of the species, individual needs of the animals, and facility constraints, however little is known about species-appropriate behaviors for this species. Indeed, some normal wild behaviors, such as males tearing limbs off of females (Okamoto 2001) are to be avoided when in human care.

**AZA Accreditation Standard**

**(1.6.1)** The institution must have a formal written enrichment and training program that promotes species-appropriate behavioral opportunities, and a training program that facilitates husbandry and veterinary procedures where appropriate.

**AZA Accreditation Standard**

**(1.6.2)** The institution must have a specific staff member(s) or committee assigned for enrichment program oversight, implementation, training, and interdepartmental coordination of enrichment efforts.

The JSC enrichment plan should include the following elements: goal setting, planning and approval process, implementation, documentation/record-keeping, evaluation, and subsequent program refinement. The JSC enrichment program should ensure that all environmental enrichment devices (EEDs) are "JSC" safe and are presented on a variable schedule to prevent habituation. AZA-accredited institutions must have a formal written enrichment program that promotes JSC-appropriate behavioral opportunities (AZA Accreditation Standard 1.6.1). JSC enrichment programs should be integrated with veterinary care, nutrition, and animal training programs to maximize the effectiveness and quality of animal care provided. AZA-accredited institutions must have specific staff members assigned to oversee, implement, train, and coordinate interdepartmental enrichment programs (AZA Accreditation Standard 1.6.2).

Typically with JSCs, enrichment is provided in three forms- spatial, dietary, and social. Some aquarium exhibits include climbing structures that the JSC do tend to utilize although their natural habitat is a sand/mud sea floor with little such relief. Indeed, too much structure in a JSC aquarium exhibit may actually impair an animal's ability to extricate itself from its old shell while molting. Some aquarists have observed that if a crab hits an obstacle while emerging from its old shell, the molting process may be impaired and the JSC may lose limbs or even perish. Dietary enrichment is also used by aquarists to offer novel food items, such as algae, starfish or gelatin diets. Interestingly, the JSCs will often react very strongly to the novel food items at first, but then ignore the items when offered again at a later date. Several aquariums care for JSCs in multi-species exhibits i(e.g., sea stars and anemones) which may add an element of social enrichment.

## 9.3 Staff Skills and Training

Aquarists caring for JSCs should be trained in all areas of JSC behavior management. A reference library appropriate to the size and complexity of the institution should be available to all staff and

volunteers to provide them with accurate information on the behavioral needs of the animals with which they work.

# Chapter 10. Research

## 10.1 Known Methodologies

AZA believes that contemporary JSC management, husbandry, veterinary care and conservation practices should be based in science, and that a commitment to scientific research, both basic and applied, is a trademark of the modern zoological park and aquarium. AZA-accredited institutions have the invaluable opportunity, and are expected, to conduct or facilitate research both in *in situ* and *ex situ* settings to advance scientific knowledge of the animals in our care and enhance the conservation of wild populations. Participating in AZA Taxon Advisory Group (TAG) or Species Survival Plan® (SSP) Program sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials could help achieve this (AZA Accreditation Standard 5.3).

**AZA Accreditation Standard**

**(5.3)** The institution should maximize the generation of scientific knowledge gained from the animals. This might be achieved by participating in AZA TAG/SSP sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

Research investigations, whether observational, behavioral, physiological, or genetically based, should have a clear scientific purpose with the reasonable expectation that they will increase our understanding of the species being investigated and may provide results which benefit the health or welfare of animals in wild populations. To date, there are no reports of formal research having been performed on JSCs in managed populations or in the wild. Informal research includes testing different methodologies at various public aquariums, as well as the husbandry survey found in Appendix F.

Japanese aquariums have collected some data on these topics, and the abstracts are paraphrased below:

> "Molting behavior of the Giant spider crab, *Macrocheira kaempferi* was observed in the laboratory. A female crab was reared under deep sea water condition. The behavior of the crab is summarized as follows: Crab loses mobility, and the rear of the carapace begins to lift. The abdomen is withdrawn. The gastric area is withdrawn. The head appendages are withdrawn. The 4th and the 3rd walking legs are withdrawn. The chelipeds are withdrawn. The second and the first (the longest limbs for a female) walking legs are withdrawn. Newly molted crab casts old cuticle. The time of molting behavior was approximately 103 minutes. The premolt, postmolt carapace width and the growth rate of the crab were 12.81 cm (5.04 in.), 15.60 cm (6.14 in.) and 21.8%, respectively (Okamoto 2008)."

> "One hundred seventy six giant spider crab ovigerous females (*Macrocheira kaempferi)* were captured using crab-pots and trawl-nets at a depth of 200–500 m (656–1640 ft.) in Suruga Bay between October 1987 and January 1994. There were no significant differences in the average number of limbs lost between crabs obtained using the crab-pots and those obtained using the trawl-net. Among the total number of females captured, only 46 (26.1%) had a complete limb complement; that is 130 (73.9%) had one or more limbs missing. *M. kaempferi* females were found to have a high degree of limb loss in comparison with other reported crab species. Among specimens with missing limbs, only one limb was missing in the majority of cases. There was no significant difference in the frequency of limb loss between the right and left sides. The pattern of limb loss differed significantly from a random pattern (x2-test, $p<0.01$). Crabs tended to lose the 1st walking legs (the longest limbs for a female) most frequently (33.2%) and chelipeds only rarely (5.7%) (Okamoto 2001)."

AZA-accredited institutions are required to have a clearly written research policy that identifies the types of research being conducted, methods used, staff involved, evaluations of the projects, the animals included, and guidelines for the reporting or publication of any findings (AZA Accreditation Standard 5.2). Institutions must designate a qualified individual to oversee and direct its research program (AZA Accreditation Standard 5.1).

**AZA Accreditation Standard**

**(5.2)** The institution must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

**AZA Accreditation Standard**

**(5.1)** Research activities must be under the direction of a person qualified to make informed decisions regarding research.

An Institutional Animal Care and Use Committee (IACUC) should be established within the institution if animals are included

in research or instructional programs. The IACUC should be responsible for reviewing all research protocols and conducting evaluations of the institution's animal care and use. If institutions are not able to conduct in-house research investigations, they are strongly encouraged to provide financial, personnel, logistical, and other support for priority research and conservation initiatives identified by Taxon Advisory Groups (TAGs) or Species Survival Plans® (SSP) Programs.

## 10.2 Future Research Needs

This Animal Care Manual is a dynamic document that will be updated as new information is acquired. Knowledge gaps have been identified throughout this Animal Care Manual and are included in this section to promote future research investigations. Knowledge gained from these areas will maximize AZA-accredited institutions' capacity for excellence in animal care and welfare as well as enhance conservation initiatives for the species. Future research could be conducted with JSCs to determine:

- new or improved husbandry techniques to reduce molting issues.
- new or improved husbandry techniques to avoid or heal black spot disease.
- successful larval rearing techniques.
- welfare metrics that are specific to this species.
- an improved understanding of JSC reproductive physiology (e.g., normal hormonal values, age of sexual maturity, bodily changes due to cycling, seasonal changes, etc.).
- an improved understanding of reproductive behaviors (e.g., gender differences, courtship behaviors, space and environmental needs, male competition, importance of sensory cues such as scent, female receptiveness, length of courting/mating periods, etc.).

# Chapter 12. Other Considerations

AZA's Ambassador Animal Scientific Advisory Group has defined an ambassador animal as an animal presented either within or outside of its normal exhibit or holding area that is intended to have regular proximity to or physical contact with trainers, handlers, the public, or will be part of an ongoing conservation education/outreach program. The AZA Aquatic Invertebrate TAG does not recommend that JSCs be considered ambassador animals, however, their molted shells can serve as excellent educational tools for aquarium guests. It is recommended that the molted shells be kept in a container where they are not touched since they are easily broken. Some aquariums have sprayed the molt with shellac or another clear spray to maintain the sturdiness of the shell.

It is imperative that the breadth of knowledge of JSCs in aquariums be vastly increased. Towards that end, the AZA Aquatic Invertebrate TAG requests that additional information that may advance this Animal Care Manual be made to them for possible inclusion in future (visit the AZA Animal Program page to contact these individuals).

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# Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to Japanese spider crabs are taken from the AZA Accreditation Standards and Related Policies (AZA, 2015) and are referenced fully within the chapters of this animal care manual:

### General Information

**(1.1.1)** The institution must comply with all relevant local, state/provincial, and federal wildlife laws and regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and regulations. In these cases the AZA standard must be met.

### Chapter 1

**(1.5.7)** The animals must be protected from weather or other environmental conditions clearly known to be detrimental to their health.

**(10.2.1)** Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment must be kept in working order and should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

**(1.5.9)** The institution must have a regular program of monitoring water quality for fish, pinnipeds, cetaceans, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

### Chapter 2

**(1.5.1)** Animals should be presented in a manner reflecting modern zoological practices in exhibit design, balancing animals' functional welfare requirements with aesthetic and educational considerations.

**(1.5.2)** All animals must be housed in enclosures and in appropriate groupings which meet their physical, psychological, and social needs. Wherever possible and appropriate, animals should be provided the opportunity to choose among a variety of conditions within their environment. Display of single animals should be avoided unless biologically correct for the species.

**(10.3.3)** All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being; and exhibit enclosures must include provisions for the behavioral enrichment of the animals. AZA housing guidelines outlined in the Animal Care Manuals should be followed.

**(10.3.4)** When sunlight is likely to cause overheating of or discomfort to the animals, sufficient shade (in addition to shelter structures) must be provided by natural or artificial means to allow all animals kept outdoors to protect themselves from direct sunlight.

**(11.3.6)** In areas where the public is not intended to have contact with animals, some means of deterring public contact with animals (e.g., guardrails/barriers) must be in place.

**(11.3.1)** All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

**(11.2.4)** All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

**(11.6.2)** Security personnel, whether staff of the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e. shooting teams).

**(11.2.5)** Live-action emergency drills must be conducted at least once annually for each of the four basic types of emergency (fire; weather/environment appropriate to the region; injury to staff or a visitor; animal escape). Four separate drills are required. These drills must be recorded and evaluated to determine that procedures are being followed, that staff training is effective, and that what is learned

is used to correct and/or improve the emergency procedures. Records of these drills must be maintained and improvements in the procedures documented whenever such are identified.

**(11.2.6)** The institution must have a communication system that can be quickly accessed in case of an emergency.

**(11.2.7)** A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

**(10.2.1)** Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment must be kept in working order and should be under a preventative maintenance program as evidenced through a record¬-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

**Chapter 3**

**(1.4.6)** A staff member must be designated as being responsible for the institution's animal recordkeeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all animal care staff members apprised of relevant laws and regulations regarding the institution's animals.

**(1.4.7)** Animal records must be kept current, and data must be logged daily.

**(1.4.4)** Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

**(1.4.5)** At least one set of the institution’s historical animal records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

**(1.4.1)** An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions at the institution.

**(1.4.2)** All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution. In both cases, notations should be made on the inventory.

**(1.4.3)** Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies/groups or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

**Chapter 4**

**(1.5.11)** Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to.

**(1.5.10)** Temporary, seasonal and traveling live animal exhibits (regardless of ownership or contractual arrangements) must meet the same accreditation standards as the institution’s permanent resident animals.

**Chapter 6**

**(2.6.2)** The institution should have a written nutrition program that meets the behavioral and nutritional needs of all species, individuals, and colonies/groups in the institution. Animal diets must be of a quality and quantity suitable for each animal’s nutritional and psychological needs.

**(2.6.1)** Animal food preparation and storage must meet all applicable laws and/or regulations.

**Chapter 7**

**(2.1.1)** A full-time staff veterinarian is recommended. In cases where such is not practical, a consulting/part-time veterinarian must be under written contract to make at least twice monthly inspections of the animals and to respond as soon as possible to any emergencies.

**(2.1.2)** So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animals24 hours a day, 7 days a week.

**(2.2.1)** Written, formal procedures must be available to the animal care staff for the use of animal drugs for veterinary purposes, and appropriate security of the drugs must be provided.

**(2.7.1)** The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals.

**(2.7.3)** Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals* developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: http://www.aazv.org/associations/6442/files/veterinary_standards_2009_final.docx.

**(2.7.2)** Written, formal procedures for quarantine must be available and familiar to all staff working with quarantined animals.

**(11.1.2)** Training and procedures must be in place regarding zoonotic diseases.

**(11.1.3)** A tuberculin (TB) testing/surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animals. Each institution must have an employee occupational health and safety program.

**(2.3.1)** Capture equipment must be in good working order and available to authorized, trained personnel at all times.

**(2.4.2)** Keepers should be trained to recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, keepers should not diagnose illnesses nor prescribe treatment.

**(1.5.8)** The institution must develop a clear process for identifying, communicating, and addressing animal welfare concerns within the institution in a timely manner, and without retribution.

**(2.5.1)** Deceased animals should be necropsied to determine the cause of death. Cadavers must be stored in a dedicated storage area. Disposal after necropsy must be done in accordance with local/federal laws.

### Chapter 9

**(1.6.1)** The institution must have a formal written enrichment and training program that promotes species-appropriate behavioral opportunities, and a training program that facilitates husbandry and veterinary procedures where appropriate.

**(1.6.2)** The institution must have specific staff member(s) or committee assigned for enrichment program oversight, implementation, training, and interdepartmental coordination of enrichment efforts.

### Chapter 10

**(5.3)** The institution should maximize the generation of scientific knowledge gained from the animals. This might be achieved by participating in AZA TAG/SSP sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

**(5.2)** The institution must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

**(5.1)** Research activities must be under the direction of a person qualified to make informed decisions regarding research.

# Appendix B: Recordkeeping Guidelines for Group Accessions

*Developed by the AZA Institutional Data Management Scientific Advisory Group*
*Published 23 May 2014*
*Edited to replace the document entitled "Updated Data Entry for Groups" published 16 December 2002*

Animals can be accessioned into a collection as either individuals or as part of a group. The term "group" has many definitions when used in zoos and aquariums, and is usually defined by its application, such as a social group or animals grouped for husbandry purposes. To provide a consistent language that can be used throughout the Association of Zoos and Aquariums (AZA), the term "group accession", as defined by the AZA Institutional Data Management Scientific Advisory Group (IDMAG),

- contains multiple animals of the same species or subspecies, which
- cannot be differentiated from one another, either physically (there are no scars or color pattern differences), artificially (they are not tagged or transpondered), or spatially (they are not held in separate enclosures), and
- are cared for as a whole.

Thus, no individually accessioned animals are included in a group accession and no individually *identifiable* animals are included in a group accession. As soon as an animal becomes individually identifiable, it is recommended that it be split from the group record and accessioned as an individual. For example, large clutches of amphibian tadpoles should first be accessioned as a group; then as individuals become identifiable, they should be removed from the group record and accessioned as individuals. Otherwise, information about an individual animal that could otherwise be tracked through the animal's life will be lost in the group record. An exception to this occurs occasionally when a group member is removed and temporarily held separately for medical treatment, with the expectation that it will be returned to the group when treatment ends. In this case, the animal remains part of the group even though separated from it. As with individual records, group record accession numbers should not duplicate any other accession number, and once a group accession number has been assigned, it should not be changed.

Group accession provides less information on specific individuals than does individual accession. Group records make information less retrievable, and often need more clarifying comments than individual records. Whenever information applies to only part of the group, notes should be used to indicate which animal(s) the information applies to. It is of utmost importance that these notes be thorough and clear so future readers can easily understand them. Examples of information needing additional notations in group records include, but are not limited to, parentage when not every member of the group has the ˇthe group. Thus, though it is preferable to accession animals as individuals, a group accession can capture considerable information when individual accession is not appropriate.

Although colonies are often confused with groups, the term "colony" should be used to designate truly colonial organisms: those that must live and function as an intact unit, such as corals and eusocial insects. Individuals within a colony are components of a single entity rather than separate members of a group. Also, colony members generally cannot be counted and true census data is not possible, so for the purposes of inventory, a colony is a singular unit while a group is composed of a number of individuals. However, for accessioning purposes, colonies are treated in the same manner as are groups.

### Examples of Appropriate Group Accessions

- A group of animals that are not individually identifiable and are the same species or subspecies.

  Your institution receives 50 Puerto Rican crested toad tadpoles to rear. Unless each tadpole is raised in a separate numbered tank, there is no way to tell one tadpole from another. All tadpoles housed together are accessioned as one group.
- Colonial species, such as coral or eusocial insects (e.g., some species of bees or ants).

  Your institution receives a piece of coral. Since the coral is in one piece, you accession it as a group of one. You make a note of the dimensions or mass of the piece to give an estimate of colony size, since it is not possible to count individual animals in the colony. In the

inventory, the colony counts as one animal. When a section of the coral breaks off, you accession that new piece as a new colony.

- A self-sustaining, breeding group of small rodents or insects.

  Your institution has a large number of Cairo spiny mice. No daily count is made, though births and deaths increase and decrease the count. A census is taken periodically, and the new count is recorded by sex and life stage. Exact counts are made whenever possible – for example, when the group is moved to a new enclosure.

- Young born to several females of the same species or subspecies and raised together without means of identifying which offspring were born to which mother.

  A flock of 3.6 peafowl raise 25 chicks this year. Identity of the hens incubating each nest, hatch dates, and number of chicks hatched from each nest can be determined and recorded. However, unless the chicks are caught and banded at hatching, once the mothers and chicks join the main flock, it is no longer possible to tell which chicks belong to which females. All chicks in the flock have the same possible parents: all the peacocks and those peahens that incubated the nests. The chicks are accessioned as a group and are split out only when they are banded or tagged (and are thus individually identifiable).

- Historical records for a species or subspecies for which there is insufficient information to attribute events to specific individuals.

  Some of your historical records are found as simple lists of events. Though there are dates for all transactions, and maybe even specified vendors or recipients for those events, you cannot create individual records for any of these animals without additional information: there is nothing connecting any specific individual to both acquisition and disposition information. If additional information is uncovered that makes this connection, then that individual can be removed from the group accession and given an individual record.

### Managing Group Records

Maintaining Group Records - As with individual records, group records should also be maintained and updated. Addition of animals through births or transactions such as loans, purchases, donations, or trades are entered as acquisitions. Subtraction of animals through deaths or transactions such as loans, sales, donations, or trades are entered as dispositions.

Weights and lengths can be entered into a group record even if that data cannot be attributed to a specific individual. This information is still useful in describing the overall condition of group members, although care should be given to describe the animal that the measurement came from. For example, is the animal a juvenile or a breeding adult? Is it healthy, or sickly? Alternatively, average and/or median measurements can be entered into the record to give an indication of what size a "normal" individual might be. In this case, notes should include the maximum and minimum measurements, and how many animals were measured to calculate the average or median.

Censuses - Groups should be censused at regular intervals - ideally, no longer than one inter-birth interval. Institutions should establish and follow a census schedule for each group. An inventory must be done at least once yearly (AZA Accreditation Standard 1.4.1) but the frequency at which a group is censused depends on species biology, husbandry protocols, and animal welfare. For species in which births/hatches and deaths tend to go undetected, or for species that have high fecundity and mortality (which makes counting every animal very difficult or impossible), census data should be obtained more frequently than for species with longer inter-birth intervals. These more frequent censuses should not be undertaken when intrusion on the group has a negative effect on the welfare of the group, e.g., disruption of maternal care.

Censuses should provide as much detail as possible by recording numbers in distinctive life stages (such as newborn, immature, adult) and/or sex ratio (such as male, female, unknown/undetermined). If the census count is estimated, the estimation method and (when possible) the accuracy of the estimate should be included. When updating the sex ratio, who sexed the animals and how they were sexed should also be recorded.

Splitting And Combining (Merging) Groups - Splitting animals from groups and combining groups together are realities of group management. Animals may be removed to create additional groups, or perhaps

new animals are received from another institution. When new groups are created, new group records also need to be created. However, if the entire group moves to a new location (such as a different tank), it retains the same accession number, and notation of the change in location is made.

When a single group is split into two or more groups, one of the new groups keeps the original accession number and the others are assigned new accession numbers. This is also true if a portion of a group is sent to another institution: the subgroup making the transfer must have an accession number distinct from that of the main group. The accession number(s) for the new group(s) should follow institutional procedures for the assignment of new accession numbers. Note of the new group accession number(s) should appear in the originating group record, and the new group accession record(s) should contain the originating group number. The reason for the split should be entered into both the originating and new group records.

When two or more groups combine to form a larger group, all but one of the groups are deaccessioned and their counts brought to zero. Notes in all the group records should indicate why the groups were merged, as well as the accession numbers of all groups involved – both the closed (empty) groups and the remaining group.

In all cases of splits and merges, the date of creation of the new record should be the same as the date of removal from the previous group or individual. Detailed notes should explain the reasons for all splits and merges.

Merging Individuals Into Groups and Splitting Individuals From Groups - Good husbandry dictates the use of identification methods that allow animals to be tracked as individuals whenever possible (AZA Accreditation Standard 1.4.3). Thus, most institutions initially accession newly-acquired animals as individual animals with individual identifiers.

Despite the best intentions, individual identification sometimes becomes impossible. For example, birds in large aviaries lose their bands; small frogs in a large terrarium die and decompose without being noticed. When individual identification of several of the animals in the group is lost and can't be resolved in a reasonable amount of time, it is best to move all potentially unidentifiable animals to a group record, by either creating a new group or merging them into an existing group. As with splitting and merging groups, the group record should contain the identities of the originating individuals and the individual records should show the new group identity. If the animals in the group ever become individually identifiable again, they can be split back to individual records to better capture demographic information. If this occurs, new accession numbers are generally needed for the new individual records since it is rarely possible to know which old individual record would apply to the newly identifiable group member.

Conversely, if one or more group members become identifiable, for example, the previously unbanded young of the year are caught up and banded, they should be split from the group record and given individual accessions. The group record should include the individual numbers assigned, and the records of all individuals should show the number of the originating group. In the case of new individual records, information particular to the animal being given the individual record (if known) should be transferred to the individual record. This includes birth date, origin, parent identification, etc. As in the cases of splitting and merging groups, the date of creation of the new record is the same as the date of removal from the previous group or individual, and detailed notes should explain the reasons for all changes in accession type.

Transfers Between Institutions - When accessioning a number of animals that were received from another institution, the new animals should be accessioned using the same type of record that the sending institution used, regardless of how the animals will ultimately be managed. If a group is received but the members will be managed as individuals, they should be accessioned as a group first, then split out as individuals. Similarly, if a number of individuals are received but the plan is to manage them as a group, they should be accessioned as individuals, then merged into a group. Although this is an extra step in the accession process, it allows the records from both institutions to more seamlessly link.

Removing Individuals From Historical Group Records - The decision of whether to use individual or group accession for historical records should be made thoughtfully and carefully. As detailed above, group accession should be used if there is insufficient information to create an *accurate* individual record. The

use of group accession is preferable to the inclusion of “best guess” information, i.e. fiction, to fill the information necessary to complete an individual record.

If additional information is later found that allows the creation of an individual record for one of the members of a historical group record, the procedure for removal from the group is different from that for current records. This situation is treated differently because the historical individual was not truly part of a group accession – the information necessary for a complete individual record was merely not known and the group accession was used “temporarily” until the required information was found or learned. For this reason, the individual should NOT be split from the group, but all reference to the individual should instead be *deleted entirely* from the group, as if it were never part of the group. This will allow the individual record to begin with the initial acquisition (instead of the date of removal from a group) and will include the animal’s entire history in one record. It also prevents inflation of inventory numbers by eliminating the possible duplication of the same information in both the group and the individual records.

# Appendix C: Guidelines for Creating and Sharing Animal and Collection Records

*Developed by the AZA Institutional Data Management Scientific Advisory Group*
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The goal of maintaining a centralized, compiled record for each animal cared for in a zoo or aquarium is ideal, however, oftentimes, information belonging in an animal record is spread across many departments and may originate with any member of the animal care staff. Therefore, it is important for zoos and aquariums to have a formal method for collecting or linking various pieces of information into the official records and that the roles and responsibilities for each named record type are clearly defined in written protocols for the reporting, recording, distribution, storage, and retrieval processes; there should also be a stated process of review for the accuracy and completeness of these records. For example, a recording/reporting protocol would state who reports births or deaths, to whom they are reported, in what manner and in what time frame they are reported, who officially records the information, and who reviews the resulting record for accuracy and completeness. Then, the maintenance and archiving protocol would state where the record is to be filed, who may have access, and how long the record is to be maintained before being archived or disposed of.

Information contained in animal records is essential not only to the immediate care of the individual animal but also as pooled data to manage larger concerns (e.g., providing norms for species-related veterinary and population management decisions, evidence of compliance with laws and regulations, showing trends in populations on every level from institutional to global, etc.). No matter what its use, it is critical for the information contained in an animal record to be factual, clear, complete, and documented. Because zoos and aquariums vary greatly in size and organizational structure, it is impossible to set defined procedures that would be applicable to all; therefore the following guidelines for creating and sharing animal records have been developed to assist with the establishment of written policies that best fit their own internal structure and protocols.

### Animal and Collection Records – Definitions and Examples

The AZA Institutional Data Management Scientific Advisory Group (IDMAG) defines an animal record as: *"data, regardless of physical form or medium, providing information about individual animals, groups of animals, or samples or parts thereof".* An animal's record may include, but is not limited to, information about its provenance, history, daily care, activities, and condition; some may originate in non-animal care departments. Some examples of animal records are:

- transaction documents (including proof of legal ownership, purchase contracts, etc.)
- identification information
- reports of collection changes (including in-house moves)
- pedigrees/lineages
- veterinary information, including images, test results, etc.
- nutrition and body condition information
- information on sampling and parts/products distribution

In addition, the IDMAG defines collection records as: *"information, evidence, rationalizations about an animal collection as a whole that may supplement or explain information contained in an animal record"*. Collection records may include, but are not limited to, documentation of collection decisions and changes, evidence of structural change at the institution, evidence of building name changes, and documentation of institution level or unit level husbandry protocols and changes. Some examples of collection records are:

- collection plans
- permits
- annual inventories (which include reconciliation with the previous year)
- area journals/notebooks (including information to/from/between other animal care staff)
- keeper reports

- animal management protocols (e.g., species hand-rearing protocols, special care or treatments, etc.)
- enclosure maps/trees
- enclosure/exhibit information (monitoring, maintenance, modifications, etc.)
- research plans and published papers

### Animal and Collection Records - Development

It is recommended that each zoo and aquarium develop written policies and procedures, applicable to all staff involved with animal care, that:

- define the types of records that are required.
  For example, daily keeper reports might be required from the keeper staff and weekly summaries of activities might be required from the animal curator and senior veterinarian.
- define the information that is to be included in each type of record.
  Following the example above, the institution would state the specific types of information to be recorded on the daily keeper report and the weekly summaries.
- define the primary location where each record can be found.
  For example, if a zoo does not employ a nutritionist, the policy or procedures might state that animal diet information will be found in keeper daily reports, curator-developed daily diets, and/or veterinarian-prescribed treatment diets.
- assign responsibility for the generation of each record type and set time limits for the their creation.
  For example, keepers might be held responsible for producing daily reports by the start of the next day and curators might be held responsible for producing weekly summaries by the Tuesday of the following week.
- define a process to review the accuracy of each record type and assign responsibility for that review process.
  For example, the identity of who will review each type of record, the date of reviews, and the review/correction processes might be included in the policy.
- define a process to identify official records and assign responsibility for the recording of, or linking of, information into these records.
  For example, the identity of who will be responsible for placing information into the official records and the processes of how to identify official records might be included in the policy.
- ensure entries in official records are never erased or deleted.
  For example, if an entry is determined to be erroneous, rather than deleting it, the entry should be amended and an audit trail should be created that identifies what data was changed, who made the change, the date it was changed, and the reason for the change.
- ensure records relating to specific animals in the collection, including the records of non--animal care departments, are permanently archived as part of the animal's record.
  For example, if your zoo or aquarium's records retention schedules differ from this recommendation every attempt should be made to exempt these records from schedules requiring their destruction.

### Animal and Collection Records – Sharing of Information

Each zoo and aquarium should assess the ownership of their animal and collection records and determine the rights of employees and outside entities to the information contained in them. It is recommended that each zoo and aquarium develop written policies and procedures for the distribution and/or availability of the animal and collection records that:

- identify who has access to animal and collection records and under what conditions.
  For example, animal care staff whose duties require a direct need for information about specific animals or collection of animals should be identified as individuals who are allowed access to any or specified records, regardless of who created them or when they were created.
- assign responsibility for the distribution, archiving and retrieval of each record type.

For example, the recordkeeper or registrar might be held responsible for maintaining all past and current transaction documents and the curator might be held responsible for maintaining the daily keeper reports from his/her section.

- define a notification system that specifies what information will be provided in the notification, who will be notified, the date they will be notified by, and the mechanism that will be used to ensure the notification is communicated appropriately.

  For example, the shipment of an animal might require that written notice be made to the senior keeper in the animal's area, the curator, and the veterinarian at least 30 days prior to the move, and identifies the animal by group or individual identification/accession number, sex, and tag/transponder number, etc.
- define where each record type (stored or archived) is available and what format (paper or digital) it is in.

  For example, all original animal transaction documents might be kept in the registrar's office in fire-proof file cabinets but copies of the Animal Data Transfer Forms are kept in the appropriate keeper area.
- define a system for obtaining necessary information such that the information is available regardless of department and regardless of staffing issues

  For example, keeper daily reports might be maintained in an electronic database run on the institution's network, to which all animal care staff members have at least read-only access.

### Implementation of these Recommendations

Well-written, consistent data-recording protocols and clear lines of communication will increase the quality of animal records and should be implemented by all institutions, regardless of technical resources. While the best option for availability of information is an electronic database system run on a computer network (intranet) to which all animal care staff members have unrestricted access, the above recommendations may also be adopted by zoos and aquariums without full electronic connections.

# Appendix D: AZA Policy on Responsible Population Management: Acquisitions, Transfers and Transitions by Zoos & Aquariums

## PREAMBLE

The Association of Zoos & Aquariums (AZA) was established, among other reasons, "…to foster continued improvement of the zoological park and aquarium profession through the development and regulation of high standards of ethics, conduct, education and scholarly attainments." The stringent requirements for AZA accreditation and high standards of professional conduct are unmatched by similar organizations and also far surpass the United States Department of Agriculture's Animal and Plant Health Inspection Service's requirements for licensed animal exhibitors. Every AZA member must abide by a Code of Professional Ethics (https://www.aza.org/Ethics/). In order to continue these high standards, AZA-accredited institutions and certified related facilities should make it a priority, when possible, to acquire animals from and transfer them to other AZA member institutions or other regional zoo associations and their members.

AZA-accredited institutions and certified related facilities cannot fulfill their important missions of conservation, education, and science without living animals. Responsible management and the long-term sustainability of living animal populations necessitates that some individuals be acquired and that others be transferred or transitioned at certain times. Furthermore, priority for acquisition and transfer activities should be the long-term sustainability of living animal populations among AZA-accredited and certified related facilities, and between AZA member institutions and non-AZA entities with animal care and welfare standards aligned with AZA. AZA member institutions that acquire animals from the wild, directly or through commercial vendors, should perform due diligence to ensure that zoos/aquariums are not creating a commercial market that promotes the taking of those animals from nature and/or that is detrimental to the survival of species in the wild. Animals should only be solicited and acquired from non-AZA entities that are known to operate legally and conduct their business in a manner that reflects and/or supports the spirit and intent of the AZA Code of Professional Ethics as well as this Policy.

In this Policy "AZA member institutions" refers to AZA-accredited institutions and certified related facilities (zoological parks and aquariums). "AZA members" may refer to either institutions or individuals.

Non – AZA entities includes facilities not accredited or certified by the AZA, facilities in other zoological regions, academic institutions, museums, research facilities, private individuals, etc.

Acquisition of animals can occur through breeding (births, hatchings, cloning, and division of marine invertebrates = "fragging"), trade, donation, lease, loan, transfer (inter- and intra-institution), purchase, collection, confiscation, appearing on zoo property, or rescue and/or rehabilitation for release.

Transfer/transition occurs when an animal leaves the institution for any reason. Reasons for transfer or transition may include cooperative population management (genetic, demographic or behavioral management), animal welfare or behavior management reasons (including sexual maturation and individual management needs). Types of transfer include withdrawal through donation, trade, lease, loan, inter- and intra-institution transfers, sale, escape, theft. Types of transition include reintroduction to the wild, humane euthanasia or natural death.

"Dispose/Disposing of" in this document is limited to complete and permanent removal of an individual via incineration, burying or other means of permanent destruction.

## I. INTRODUCTION

The AZA Acquisition, Transfer and Transition Policy was created to help (1) guide and support AZA-accredited and certified related facilities in their animal acquisition and transfer/transition decisions, and (2) make certain that all acquisitions and transfers/transitions are compatible with the Association's stated commitment to save and protect the wonders of the living natural world. This AZA Acquisition, Transfer and Transition Policy applies to individual animals, groups/colonies, and specimens (animal parts, materials, and products). More specifically, the AZA Acquisition, Transfer and Transition Policy provides guidance to AZA members to:

1. assure that the health and welfare of individual animals is considered during acquisition and transfer/transition activities,

2. assure that the health and conservation of populations, species, and ecosystems are carefully considered during acquisition and transfer/transition activities,
3. maintain a proper standard of conduct for AZA members during acquisition and transfer/transition activities, including adherence to all applicable laws and regulations,
4. assure that animals from AZA member institutions and certified related facilities are not transferred to individuals or organizations that lack the appropriate expertise or facilities to care for them [*see taxa specific appendices (in development)*], and
5. support the goals of AZA's cooperatively managed populations and associated Animal Programs [Species Survival Plans® (SSPs), Studbooks, and Taxon Advisory Groups (TAGs)].

Attempts by members to circumvent AZA Animal Programs in the acquisition of animals can be detrimental to the Association and its Animal Programs. Such action may also be detrimental to the species involved and may be a violation of the Association's Code of Professional Ethics.

AZA's scientifically-managed Animal Programs, including SSPs, have successfully bred and reintroduced critically endangered species for the benefit of humankind. To accomplish these critical conservation goals, populations must be managed within "carrying capacity" limits. At times, the number of individual animals in a population exceeds carrying capacity, and while meaning no disrespect for these individual animals, we refer to these individual animals as "extra" within the managed population.

This AZA Acquisition, Transfer and Transition Policy will serve as the default policy for AZA member institutions. Institutions may develop their own Acquisition, Transfer and Transition Policy in order to address specific local concerns. Any institutional policy must incorporate and not conflict with the AZA acquisition and transfer/transition standards.

**II. LAWS, AUTHORITY, RECORD-KEEPING, IDENTIFICATION AND DOCUMENTATION**

The following must be considered with regard to the acquisition or transfer/transition of all living animals and specimens (their living and non-living parts, materials, and/or products):

Examples of specimens include animal parts, materials and products including bodily fluids, cell lines, clones, digestive content, DNA, feces, marine invertebrate (coral) fragments ("frags"), germplasm, and tissues

1. Any acquisitions, transfers, and transitions must meet the requirements of all applicable local, state, federal and international laws and regulations. Ownership and any applicable chain-of-custody must be documented. If such information does not exist, an explanation must be provided regarding such animals and specimens. Any acquisition of free-ranging animals must be done in accordance with all local, state, federal, and international laws and regulations and must not be detrimental to the long-term viability of the species in the wild.
2. The Director/Chief Executive Officer of the institution must have final authority for all acquisitions and transfers/transitions.
3. Acquisitions or transfers/transitions must be documented through institutional record keeping systems. The ability to identify which animal is being transferred is very important and the method of identifying the animal should be documented. Any existing documentation must accompany all transfers. To standardize institutional animal records data, records guidelines have been developed for certain species (https://www.aza.org/AnimalCare/detail.aspx?id=3150).
4. For some colonial, group-living, or prolific species, it may be impossible or highly impractical to identify individual animals when these individuals are maintained in a group. When considered as a group, these species are therefore maintained, acquisitioned, transferred, and transitioned as a group or colony, or as part of a group or colony.

Examples of colonial, group-living, or prolific species include and are not limited to certain terrestrial and aquatic invertebrates, fish, sharks/rays, amphibians, reptiles, birds, rodents, bats, big herds, and other mammals,

5. If the intended use of specimens is to create live animal(s), their acquisition and transfer should follow the same guidelines. If germplasm is acquired or transferred with the intention of creating live animal(s), ownership of the offspring must be clearly defined in transaction documents (e.g., breeding loan agreements).

Institutions acquiring, transferring, transitioning or disposing of specimens should consider current and possible future uses as new technologies become available. All specimens from which nuclear DNA could be recovered should be carefully considered as these basic DNA extraction technologies already exist.

6. AZA member institutions must maintain transaction documents (e.g., confirmation forms, breeding agreements) which provide the terms and conditions of animal acquisitions, transfers and loans, including documentation for animal parts, products and materials. These documents should require the potential recipient or provider to adhere to the AZA Acquisition, Transfer and Transition Policy, all relevant AZA and member policies, procedures and guidelines, and the AZA Code of Professional Ethics, and must require compliance with the applicable laws and regulations of local, state, federal, and international authorities.
7. In the case of animals (living or non-living) and their parts, materials, or products (living or non-living) held on loan, the owner's written permission should be obtained prior to any transfer and should be documented in the institutional records.
8. AZA SSP and TAG necropsy and sampling protocols should be accommodated.
9. Some governments maintain ownership of the species found within their borders. It is therefore incumbent on institutions to determine whether animals they are acquiring or transferring are owned by a government entity, foreign or domestic, and act accordingly by reviewing the government ownership policies available on the AZA website. In the case of government owned animals, proposals for and/or notifications of transfers must be sent to the species manager for the government owned species.

Transaction documents must be signed by the authorized representatives of both parties, and copies must be retained by both parties*. In the case of loans, the owner's permission for appropriate activities should be documented in the institutional records. This document(s) should be completed prior to any transfer. In the case of rescue, confiscation, and evacuation due to natural disasters, it is understood that documents may not be available until after acceptance or shipping. In this case documentation (e.g., a log) must be kept to reconcile the inventory and chain of custody after the event occurs.

*In the case of government owned animals, notification of transfers must be sent to species manager for the government owned species.

## III. ACQUISITION REQUIREMENTS

### A. General Acquisitions

1. Acquisitions must be consistent with the mission of the institution, as reflected in its Institutional Collection Plan, by addressing its exhibition/education, conservation, and/or scientific goals.
2. Animals (wild, feral, and domestic) may be held temporarily for reasons such as assisting governmental agencies or other institutions, rescue and/or rehabilitation, research, propagation or headstarting for reintroduction, or special exhibits.
3. Any receiving institution must have the necessary expertise and resources to support and provide for the professional care and management of the species, so that the physical, psychological, and social needs of individual animals and species are met.
4. If the acquisition involves a species managed by an AZA Animal Program, the institution should communicate with the Animal Program Leader and, in the case of Green SSP Programs, must adhere to the AZA Full Participation Policy (http://www.aza.org/full-participation-in-ssp-program-policy/).
5. AZA member institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved TAG Regional Collection Plans (RCPs), Animal Program Leaders, and AZA Animal Care Manuals (ACMs) when making acquisition decisions.
6. AZA member institutions that work with commercial vendors that acquire animals from the wild, must perform due diligence to assure the vendors' collection of animals is legal. Commercial vendors should have conservation and animal welfare goals similar to those of AZA institutions.

Feral animals are animals that have escaped from domestication or have been abandoned to the wild and have become wild, and the offspring of such animals. Feral animals may be acquired for temporary or permanent reasons.

7. AZA member institutions may acquire animals through public donations and other non-AZA entities when it is in the best interest of the animal and/or species.

### B. Acquisitions from the Wild

Saving species and wild animal populations for education and wildlife conservation purposes is a unique responsibility of AZA member zoos and aquariums. The AZA recognizes that there are circumstances where acquisitions from the wild are needed in order to maintain healthy, diverse animal populations and to support the objectives of managed species programs, in which case acquisitions from the wild may be a preferable choice to breeding in human care.

Acquiring animals from the wild can result in socioeconomic benefit and environmental protection and therefore the AZA encourages environmentally sustainable/beneficial acquisition from the wild when conservation is a positive outcome.

1. Before acquiring animals from the wild, institutions are encouraged to examine alternative sources including other AZA institutions and other regional zoological associations or other non-AZA entities.
2. When acquiring animals from the wild, both the long-term health and welfare impacts on the wild population as well as on individual animals must be considered. In crisis situations, when the survival of a population is at risk, rescue decisions will be made on a case-by-case basis by the appropriate agency and institution.
3. Institutions should only accept animals from the wild after a risk assessment determines the zoo/aquarium can mitigate any potential adverse impacts on the health, care and maintenance of the permanently housed animals, and the animals being acquired.

## IV. TRANSFER AND TRANSITION REQUIREMENTS

### A. Living Animals

Successful conservation and animal management relies on the cooperation of many entities, both AZA and non-AZA. While preference is given to placing animals with AZA-accredited institutions or certified related facilities, it is important to foster a cooperative culture among those who share AZA's mission of saving species.

The Lacey Act prohibits the importation, exportation, transportation, sale, receipt, acquisition or purchase of wildlife taken or possessed in violation of any law, treaty or regulation of the United States or any Indian tribal law of wildlife law.

In cases when there is no documentation accompanying an acquisition, the animal(s) may not be transferred across state lines. If the animal was illegally acquired at any time then any movement across state or international borders would be a violation of the Lacey Act.

1. Any transfer must abide by the Mandatory Standards and General Advisories of the AZA Code of Professional Ethics which indicates that AZA members should assure that all animals in their care are transferred and transitioned in a manner that meets the standards of the Association, and that animals are not transferred or transitioned to those not qualified to care for them properly.
2. If the transfer of animals or their specimens (parts, materials, and products) involves a species managed by an AZA Animal Program, the institution should communicate with that Animal Program Leader and, in the case of Green SSP Programs must adhere to the AZA Full Participation Policy (http://www.aza.org/full-participation-in-ssp-program-policy/).
3. AZA member institutions should consult WCMC-approved TAG Regional Collection Plans, Animal Program Leaders, and Animal Care Manuals when making transfer decisions.
4. Animals acquired as animal feed are not typically accessioned into the collection. There may be occasions, however, when it is appropriate to use accessioned animals that exceed population carrying capacity as feeder animals to support other animals. In some cases, accessioned animals may be transitioned to "feeder animal" status by

Attempts by members to circumvent AZA Animal Programs in the transfer or transition of animals may be detrimental to the Association and its Animal Programs (unless the animal or animals are deemed extra in the Animal Program population by the Animal Program Coordinator). Such action may be detrimental to the species involved and may be a violation of the Association's Code of Professional Ethics.

the local institution as part of their program for long-term sustained population management of the species.

5. In transfers to non-AZA entities, AZA members must perform due diligence and should have documented validation, such as a letter of reference, that the recipient has the expertise and resources required to properly care for and maintain the animals. Supporting documentation must be kept at the AZA member institution.

> Examples of "Transition" include movements of animals from zoo/aquarium populations to the wild through reintroductions or other legal means, or the transition of an animal from living to dead.

6. Domestic animals should be transferred in accordance with locally acceptable farm practices, including auctions, and subject to all relevant laws and regulations.
7. AZA members must not send any non-domestic animal to auction or to any organization or individual that may display or sell the animal at an animal auction. *See certain taxa-specific appendices to this Policy (in development) for information regarding exceptions*.
8. Animals must not be sent to organizations or individuals that allow the hunting of these individual animals; that is, no animal from an AZA institution may be hunted. For purposes of maintaining sustainable zoo and aquarium populations, AZA-accredited institutions and certified related facilities may send animals to non-AZA organizations or individuals. These non-AZA entities (for instance, ranching operations) should follow appropriate ranch management practices and other conservation minded practices to support population sustainability.

> Examples of documentation include ZIMS records, "Breeding Loan" agreements, chain-of-custody logs, letters of reference, transfer agreements, and transaction documents

9. Every loaning institution must annually monitor and document the conditions of any loaned specimen(s) and the ability of the recipient(s) to provide proper care. If the conditions and care of animals are in violation of the loan agreement, the loaning institution must recall the animal or assure prompt correction of the situation. Furthermore, an institution's loaning policy must not be in conflict with this AZA Acquisition, Transfer and Transition Policy.

> Examples of domestic animals may include certain camelids, cattle, cats, dogs, ferrets, goats, pigs, reindeer, rodents, sheep, budgerigars, chickens, doves, ducks, geese, pheasants, turkeys, and goldfish or koi.

10. If living animals are sent to a non-AZA entity for research purposes, it must be a registered research facility by the U.S. Department of Agriculture and accredited by the Association for the Assessment & Accreditation of Laboratory Animal Care, International (AAALAC), if eligible. For international transactions, the receiving facility must be registered by that country's equivalent body having enforcement over animal welfare. In cases where research is conducted, but governmental oversight is not required, institutions should do due diligence to assure the welfare of the animals during the research.
11. Transition: reintroductions and release to the wild. The reintroduction of animals must meet all applicable local, state, and international laws and regulations. Reintroductions may be a part of a recovery program and must be compatible with the IUCN Reintroduction Specialist Group's Reintroduction Guidelines (http://www.iucnsscrsg.org/index.php).
12. Transition: humane euthanasia. Humane euthanasia may be employed for medical reasons to address quality of life issues for animals or to prevent the transmission of disease. AZA also recognizes that humane euthanasia may be employed for managing the demographics, genetics, and diversity of animal populations. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV's Guidelines on the Euthanasia of Non-Domestic Animals.

**B. Non-Living Animals and Specimens**

AZA members should optimize the use and recovery of animal remains. All transfers must meet the requirements of all applicable laws and regulations.

1. Optimal recovery may include performing a complete necropsy including, if possible, histologic evaluation of tissues which should be a key component of optimal recovery before specimens' use in education/exhibits. AZA SSP and TAG necropsy and sampling protocols should be accommodated. This information should be available to SSP Programs for population management.
2. The educational use of non-living animals, parts, materials, and products should be maximized, and their use in Animal Program sponsored projects and other scientific projects that provide data for species management and/or conservation must be considered.
3. Non-living animals, if handled properly to protect the health of the recipient animals, may be utilized as feeder animals to support other animals as deemed appropriate by the institution.
4. AZA members should consult with AZA Animal Program Leaders prior to transferring or disposing of remains/samples to determine if existing projects or protocols are in place to optimize use.
5. AZA member institutions should develop agreements for the transfer or donation of non-living animals, parts, materials, products, and specimens and associated documentation, to non-AZA entities such as universities and museums. These agreements should be made with entities that have appropriate long term curation/collections capacity and research protocols, or needs for educational programs and/or exhibits.

When specimens are transferred, the transferring and receiving institutions should agree on data that must be transferred with the specimen(s). Examples of associated documentation include provenance of the animal, original permits, tags and other metadata, life history data for the animal, how and when specimens were collected and conserved, etc.

It is best practice for modern zoos and aquariums to establish relationships with nearby museums or other biorepositories, so that they can maximize the value of animals when they die (e.g., knowing who to call when they have an animal in necropsy, or specimens for cryopreservation).

Natural history museums that are members of the Natural Science Collections Alliance (NSCA) and frozen biorepositories that are members of the International Society of Biological and Environmental Repositories (ISBER) are potential collaborators that could help zoos find appropriate repositories for biological specimens.

# Appendix E: Recommended Quarantine Procedures

Quarantine facility: A separate quarantine facility, with the ability to accommodate mammals, birds, reptiles, amphibians, and fish should exist. If a specific quarantine facility is not present, then newly acquired animals should be isolated from the established collection in such a manner as to prohibit physical contact, to prevent disease transmission, and to avoid aerosol and drainage contamination.

Such separation should be obligatory for primates, small mammals, birds, and reptiles, and attempted wherever possible with larger mammals such as large ungulates and carnivores, marine mammals, and cetaceans. If the receiving institution lacks appropriate facilities for isolation of large primates, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applied to the receiving institutions protocol. In such a case, shipment must take place in isolation from other primates. More stringent local, state, or federal regulations take precedence over these recommendations.

Quarantine length: Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). Mammals: If during the 30-day quarantine period, additional mammals of the same order are introduced into a designated quarantine area, the 30-day period must begin over again. However, the addition of mammals of a different order to those already in quarantine will not have an adverse impact on the originally quarantined mammals. Birds, Reptiles, Amphibians, or Fish: The 30-day quarantine period must be closed for each of the above Classes. Therefore, the addition of any new birds into a bird quarantine area requires that the 30-day quarantine period begin again on the date of the addition of the new birds. The same applies for reptiles, amphibians, or fish.

Quarantine personnel: A keeper should be designated to care only for quarantined animals or a keeper should attend quarantined animals only after fulfilling responsibilities for resident species. Equipment used to feed and clean animals in quarantine should be used only with these animals. If this is not possible, then equipment must be cleaned with an appropriate disinfectant (as designated by the veterinarian supervising quarantine) before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal care personnel to zoonotic diseases that may be present in newly acquired animals. These precautions should include the use of disinfectant foot baths, wearing of appropriate protective clothing and masks in some cases, and minimizing physical exposure in some species; e.g., primates, by the use of chemical rather than physical restraint. A tuberculin testing/surveillance program must be established for zoo/aquarium employees in order to ensure the health of both the employees and the animal collection.

Quarantine protocol: During this period, certain prophylactic measures should be instituted. Individual fecal samples or representative samples from large numbers of individuals housed in a limited area (e.g., birds of the same species in an aviary or frogs in a terrarium) should be collected at least twice and examined for gastrointestinal parasites. Treatment should be prescribed by the attending veterinarian. Ideally, release from quarantine should be dependent on obtaining two negative fecal results spaced a minimum of two weeks apart either initially or after parasiticide treatment. In addition, all animals should be evaluated for ectoparasites and treated accordingly.

Vaccinations should be updated as appropriate for each species. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a 70 °C (-94 °F) frost-free freezer or a 20 °C (-4 °F) freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation.

The quarantine period also represents an opportunity to, where possible, permanently identify all unmarked animals when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Also, whenever animals are restrained or immobilized, a complete physical, including a dental examination, should be performed. Complete medical records should be maintained and available for all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed under the supervision of a veterinarian and representative tissues submitted for histopathologic examination.

Quarantine procedures: The following are recommendations and suggestions for appropriate quarantine procedures for Japanese spider crabs:

*Japanese spider crabs:*

Suggested:

1. Direct and floatation fecals
2. Vaccinate as appropriate

Not applicable:

1. CBC/sera profile
2. Urinalysis
3. Appropriate serology (FIP, FeLV, FIV)
4. Heartworm testing in appropriate species

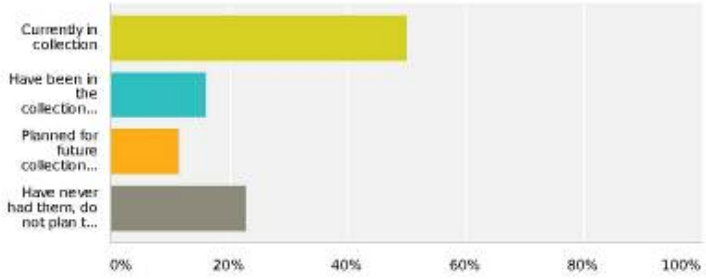
# Appendix F: Macrocheira Husbandry Survey

Undertaken by Jay Hemdal in 2011 through voluntary participation of public aquarists from around the world and utilizing the Survey Monkey website software (http://www.surveymonkey.com/s/macrocheira).

Giant Spider Crab - Macrocheira Husbandry Survey

## Q2 What is the current status of Macrocheira in your collection?

Answered: 44 Skipped: 0

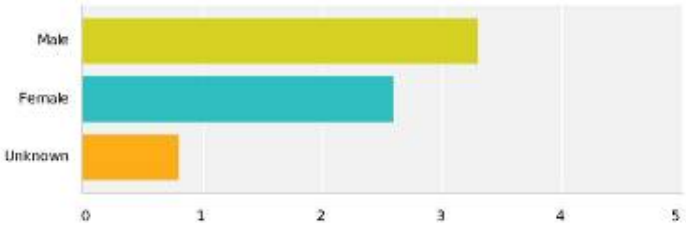



| Answer Choices | Responses | |
|---|---|---|
| **Currently in collection** | **50%** | 22 |
| **Have been in the collection in the past** | **15.91%** | 7 |
| **Planned for future collection (skip to end of survey)** | **11.36%** | 5 |
| **Have never had them, do not plan to acquire (skip to end)** | **22.73%** | 10 |
| Total | | 44 |

Giant Spider Crab - Macrocheira Husbandry Survey

## Q3 If you currently hold Macrocheiria, please indicate number of animals of each sex:

Answered: 22 Skipped: 22

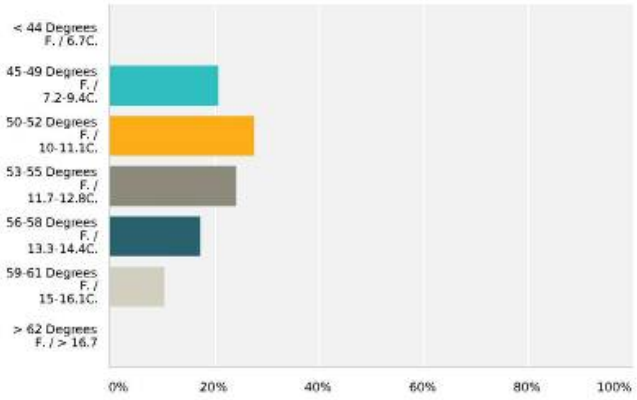



| Answer Choices | Average Number | Total Number | Responses |
|---|---|---|---|
| **Male** | **3.29** | **56** | 17 |
| **Female** | **2.59** | **44** | 17 |
| **Unknown** | **0.80** | **4** | 5 |
| Total Respondents: 22 | | | |

Giant Spider Crab - Macrocheira Husbandry Survey

## Q4 What water temperature range most closely matches the target water temperature of your exhibit(s)?

Answered: 29 Skipped: 15

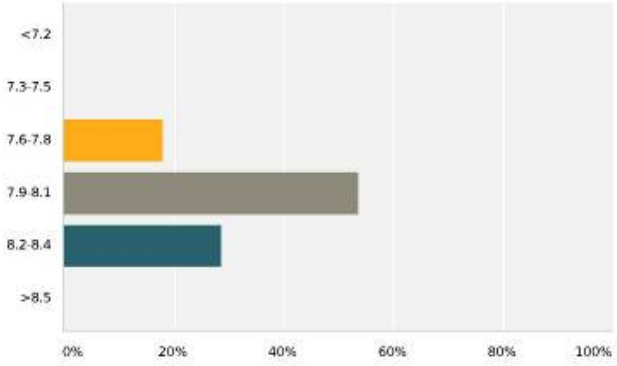



| Answer Choices | Responses | |
|---|---|---|
| **< 44 Degrees F. / 6.7C.** | **0%** | 0 |
| **45-49 Degrees F. / 7.2-9.4C.** | **20.69%** | 6 |
| **50-52 Degrees F. / 10-11.1C.** | **27.59%** | 8 |
| **53-55 Degrees F. / 11.7-12.8C.** | **24.14%** | 7 |
| **56-58 Degrees F. / 13.3-14.4C.** | **17.24%** | 5 |
| **59-61 Degrees F. / 15-16.1C.** | **10.34%** | 3 |
| **> 62 Degrees F. / > 16.7** | **0%** | 0 |
| Total | | 29 |

Giant Spider Crab - Macrocheira Husbandry Survey

## Q5 What is the typical pH range for your crab system(s):

Answered: 28 Skipped: 16

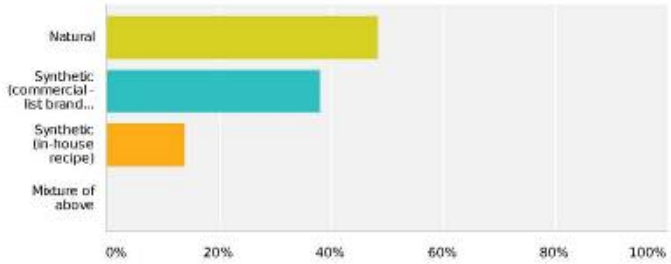



| Answer Choices | Responses | |
|---|---|---|
| **<7.2** | **0%** | 0 |
| **7.3-7.5** | **0%** | 0 |
| **7.6-7.8** | **17.86%** | 5 |
| **7.9-8.1** | **53.57%** | 15 |
| **8.2-8.4** | **28.57%** | 8 |
| **>8.5** | **0%** | 0 |
| Total | | 28 |

Giant Spider Crab - Macrocheira Husbandry Survey

## Q6 What is your source for seawater?

Answered: 29 Skipped: 15

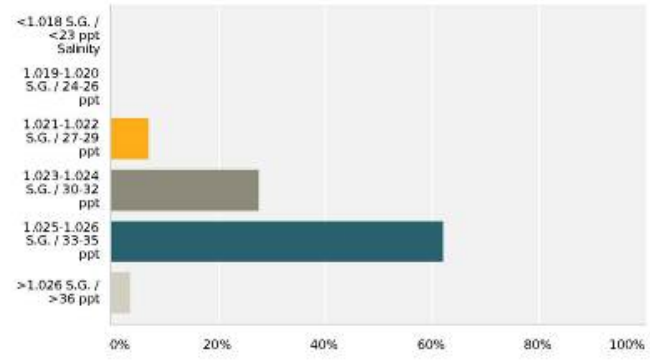



| Answer Choices | Responses | |
|---|---|---|
| **Natural** | **48.28%** | 14 |
| **Synthetic (commercial - list brand below)** | **37.93%** | 11 |
| **Synthetic (in-house recipe)** | **13.79%** | 4 |
| **Mixture of above** | **0%** | 0 |
| Total | | 29 |

Giant Spider Crab - Macrocheira Husbandry Survey

## Q8 What specific gravity OR salinity do you house your crabs at?

Answered: 29 Skipped: 15

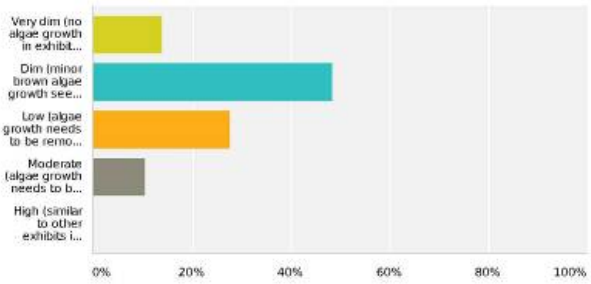



| Answer Choices | Responses | |
|---|---|---|
| **<1.018 S.G. / <23 ppt Salinity** | **0%** | 0 |
| **1.019-1.020 S.G. / 24-26 ppt** | **0%** | 0 |
| **1.021-1.022 S.G. / 27-29 ppt** | **6.90%** | 2 |
| **1.023-1.024 S.G. / 30-32 ppt** | **27.59%** | 8 |
| **1.025-1.026 S.G. / 33-35 ppt** | **62.07%** | 18 |
| **>1.026 S.G. / >36 ppt** | **3.45%** | 1 |
| Total | | 29 |

Giant Spider Crab - Macrocheira Husbandry Survey

## Q9 What is the light level of your Macrocheira exhibit typically kept at:

Answered: 29 Skipped: 15

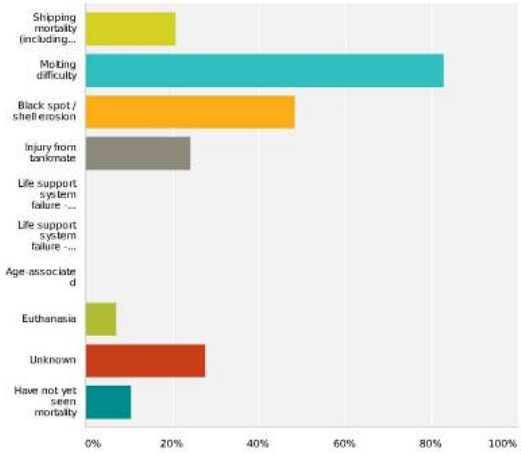



| Answer Choices | Responses | |
|---|---|---|
| **Very dim (no algae growth in exhibit or on crab shells) <20 Lux** | **13.79%** | 4 |
| **Dim (minor brown algae growth seen) 25-75 Lux** | **48.28%** | 14 |
| **Low (algae growth needs to be removed - but infrequently) 100-300 Lux** | **27.59%** | 8 |
| **Moderate (algae growth needs to be removed monthly) 500-1500 Lux** | **10.34%** | 3 |
| **High (similar to other exhibits in the facilty >1500 Lux** | **0%** | 0 |
| Total | | 29 |

Giant Spider Crab - Macrocheira Husbandry Survey

## Q10 What causes of mortality have you seen/suspected in Macrocheira at your facility? Please select all that apply.

Answered: 29 Skipped: 15




| Answer Choices | Responses | |
|---|---|---|
| **Shipping mortality (including 24 hours post-shipment)** | **20.69%** | 6 |
| **Molting difficulty** | **82.76%** | 24 |
| **Black spot / shell erosion** | **48.28%** | 14 |
| **Injury from tankmate** | **24.14%** | 7 |
| **Life support system failure - temperature control** | **0%** | 0 |
| **Life support system failure - water quality** | **0%** | 0 |
| **Age-associated** | **0%** | 0 |
| **Euthanasia** | **6.90%** | 2 |
| **Unknown** | **27.59%** | 8 |
| **Have not yet seen mortality** | **10.34%** | 3 |

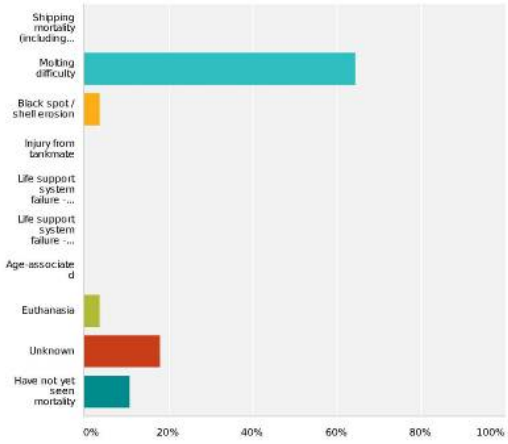
Total Respondents: 29

Other (please specify) ( 3 )

Giant Spider Crab - Macrocheira Husbandry Survey

## Q11 What is the most SERIOUS cause of unresolved mortality at your facility?

Answered: 28 Skipped: 16

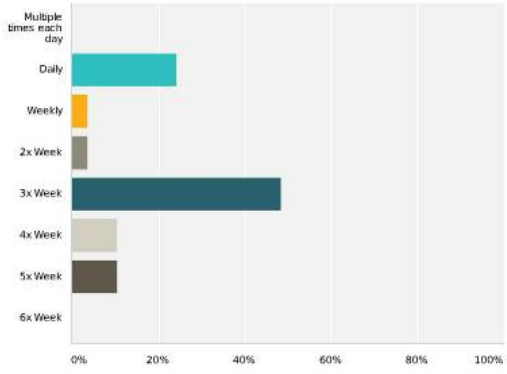



| Answer Choices | Responses | |
|---|---|---|
| **Shipping mortality (including 24 hours post-shipment)** | **0%** | 0 |
| **Molting difficulty** | **64.29%** | 18 |
| **Black spot / shell erosion** | **3.57%** | 1 |
| **Injury from tankmate** | **0%** | 0 |
| **Life support system failure - temperature control** | **0%** | 0 |
| **Life support system failure - water quality** | **0%** | 0 |
| **Age-associated** | **0%** | 0 |
| **Euthanasia** | **3.57%** | 1 |
| **Unknown** | **17.86%** | 5 |
| **Have not yet seen mortality** | **10.71%** | 3 |
| Total | | 28 |

Giant Spider Crab - Macrocheira Husbandry Survey

## Q12 Typically, how often are the crabs fed?

Answered: 29 Skipped: 15

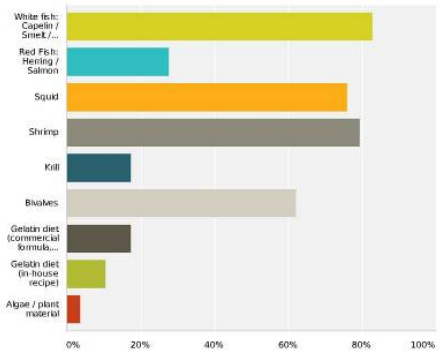



| Answer Choices | Responses | |
|---|---|---|
| **Multiple times each day** | **0%** | 0 |
| **Daily** | **24.14%** | 7 |
| **Weekly** | **3.45%** | 1 |
| **2x Week** | **3.45%** | 1 |
| **3x Week** | **48.28%** | 14 |
| **4x Week** | **10.34%** | 3 |
| **5x Week** | **10.34%** | 3 |
| **6x Week** | **0%** | 0 |
| Total | | 29 |

Giant Spider Crab - Macrocheira Husbandry Survey

**Q13 What food items are routinely fed to the Macrocheira at your facility?**

Answered: 29 Skipped: 15

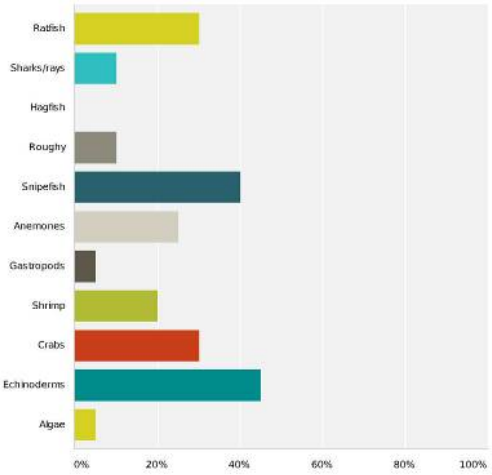



| Answer Choices | Responses | |
|---|---|---|
| **White fish: Capelin / Smelt / Silversides** | **82.76%** | 24 |
| **Red Fish: Herring / Salmon** | **27.59%** | 8 |
| **Squid** | **75.86%** | 22 |
| **Shrimp** | **79.31%** | 23 |
| **Krill** | **17.24%** | 5 |
| **Bivalves** | **62.07%** | 18 |
| **Gelatin diet (commercial formula, please identify company)** | **17.24%** | 5 |
| **Gelatin diet (in-house recipe)** | **10.34%** | 3 |
| **Algae / plant material** | **3.45%** | 1 |
| Total Respondents: 29 | | |
| Other (please specify) ( 12 ) | | |

Giant Spider Crab - Macrocheira Husbandry Survey

**Q14 What other species have you SUCCESSFULLY housed long-term with Macrocheira? (Meaning; minimal to no aggression seen between species, and you would expect them to live together well for over a year)**

Answered: 20 Skipped: 24




| Answer Choices | Responses | |
|---|---|---|
| **Ratfish** | **30%** | 6 |
| **Sharks/rays** | **10%** | 2 |
| **Hagfish** | **0%** | 0 |
| **Roughy** | **10%** | 2 |
| **Snipefish** | **40%** | 8 |
| **Anemones** | **25%** | 5 |
| **Gastropods** | **5%** | 1 |
| **Shrimp** | **20%** | 4 |
| **Crabs** | **30%** | 6 |
| Total Respondents: 20 | | |