Husbandry Guidelines
Apodiformes
**Hummingbirds-Trochilidae**
Karen Krebbs, Conservation Biologist / Arizona-Sonora Desert Museum / Tucson, AZ
Dave Rimlinger, Curator of Ornithology / San Diego Zoo / San Diego, CA
Michael Mace, Curator of Ornithology / San Diego Wild Animal Park / Escondido, CA
September, 2002

## 1. ACQUISITION AND ACCLIMATIZATION

*Sources of birds & acclimatization procedures* -
In the United States local species of hummingbirds can be collected with the proper permits. The Arizona-Sonora Desert Museum usually has species such as Anna's (*Calypte anna)*, Costa's (*Calypte costae)*, and Broad-billed *(Cynanthus latirostris)* for surplus each year if these species have nested in their Hummingbird Exhibit. In addition to keeping some native species, the San Diego Zoo has tried to maintain several exotic species such as Sparkling violet-ear *(Colibri coruscans)*, Emerald *(Amazilia amazilia)*, Oasis *(Rhodopis vesper)*, etc. The San Diego Wild Animal Park has a large mixed species glass walk-through enclosure and has kept and produced hummingbirds over the years. All hummingbirds are on Appendix II of CITES and thus are covered under the Wild Bird Conservation Act (WBCA). An import permit from USFWS and an export permit from the country of origin must be obtained prior to the importation. Permits have been granted in the past, but currently it is difficult to find a country willing to export hummingbirds. Hummingbirds are more commonly kept in European collections, particularly private collections, and could be a source for future imports.

*Weighing*
Hummingbirds can be placed in a soft mesh bag and weighed with a spring scale. Electronic digital platform scales can also be used. A small wooden crate with a wire mesh front can also be used for weighing.

*Feeding wild caught birds, getting newly acquired birds onto captive diet* -
Wild caught hummingbirds were probably easily trapped because they were going to feeders that contained sugar water. Therefore, the birds should be weaned off of the sugar water and fed a nutritionally complete diet. While in quarantine the birds can be fed both sugar water and a complete balanced food during the first few days. Offer both the sugar water and the packaged nectar in separate feeders and the birds usually wean themselves over to the nutritional captive diet within a day of their capture. Fruit flies should also be offered to the bird.
To encourage hummers to feed from a feeder for the first few days it is helpful to attach a recognizable flower to the feeder. This encourages the bird to recognize the feeder as a nutrition source. It is recommended to offer a feeder containing a nutritional balanced nectar diet as well as the sugar solution. Considering that you are dealing with wild caught birds that are acclimatizing to the new food it is also suggested that you offer a feeder containing water in case the solution is not of a desired concentration for the first few weeks.

## 2. HOUSING, ENCLOSURE, AND ENVIRONMENTAL REQUIREMENTS

**General Housing Considerations --**

*Temperature / humidity* - Although hummingbirds are found from Alaska to Tierra del Fuego, they are more numerous in the tropics. Some of the species in high latitudes do encounter freezing temperatures and have adapted to these extremes, while others endure the high temperatures of desert habitats. Depending on the species, hummingbirds can endure different temperature and humidity extremes. Special considerations should be kept in mind for each species and the area and habitat they would occupy in the wild. If hummingbirds are expected to endure either hot or cold temperatures in a captive situation, the following should apply:

1. They should be in excellent physical condition.
2. They should have adequate vegetation that provides rest, sleep, shade, and nest areas.
3. They should have access to a heat source in the winter such as a heat lamp. If you need to offer supplemental heat, you must consider territories and it is best to offer one heat source per bird. This way the birds won't fight over the heat.
4. They should have access to a waterfall or area they can bathe.
5. The daytime temperature should not stay below freezing.
6. The outdoor aviary or holding areas should be covered on the top with tarpaulin or equivalent cover to protect from cold temperatures, wind, snow, ice, hale, and rain when these environmental extremes occur.

*Natural light* - Outdoor aviaries are usually more successful when exhibiting or holding hummingbirds. In some of the more northern latitudes this may not be possible due to the weather extremes. Natural light seems important to the hummingbird's health, well-being, and nesting success. Indoor aviaries or holding areas should utilize natural light whenever possible in the form of skylights, windows, etc.

*Water quality* - For food preparation and bathing, the water quality should be void of chemicals. The water should be tested on a regular basis for iron or impurities. Even small amounts of impurities can mean illness or mortality to a hummingbird.

*Air filtration* - Indoor aviaries and holding areas should have good quality air and lack pollutants. Outdoor aviaries should not have problems with this.

*Waste disposal* - Indoor aviaries should be hosed daily, not so much for waste, but for nectar dripping on floors. Unclean floors can attract ants and other insects. The floors should have good drainage so that water does not pool in these areas. Outdoor aviaries or holding areas should have a good soil substrate and any hard surfaces like concrete should also have good drainage.

*Insects* - Nectar that is fed to hummingbirds can attract ants. Indoor holding cages should have ant

guards to protect birds and feeders. Legs of the holding cages can be set in containers filled with water to prevent ants from crawling up to the feeders or perches. Vaseline rubbed on feeder hooks or wires will also discourage ants. Insecticide should never be used to control ants or other insects around hummingbirds. Vaseline or Tanglefoot can be used with extreme caution. It is recommended to use on vertical objects such as the wire holding feeders. If you can cover the ant barrier with a device that will prevent the hummers from coming into direct contact with the ant barrier that would be the best method. Ant bait stations can be used if placed in locations that preclude the birds from coming into contact with the bait. Insecticides can be used if injected directly into an underground any nest.

**Quarantine (isolation) cage set-up--**

Quarantine is necessary to guard against diseases new birds may harbor and to care for birds that are ill. Unfortunately, when many hummingbird species exhibit signs of illness they are already declining and efforts to improve their condition may not help. Also the veterinary care and medication for hummingbirds has not been perfected for such a small sized bird. But quarantine does serve the purpose of isolating the new or ill bird. Since many hummingbird species are collected from the wild, quarantine also allows these birds to acclimate to captivity in an enclosed area. It can be a stressful time for hummingbirds and efforts should be made to minimize the time spent in isolation. Normal quarantine time should be from 30 to 60 days (4 - 8 weeks) depending on the bird and circumstances.

*Wire Mesh*

A standard wire mesh such as 2 inch x 2 inch, 2 inch x ¼ inch, ½ inch x 3 inch, or ¼ inch x ¼ inch will be suitable for a small (quarantine) cage for hummingbirds. ZooMesh (TM) can also be utilized for cages holding hummingbirds.

*Glass Enclosures*

A glass enclosure can be utilized if precautions are taken in preparation to exhibit birds. The greatest obstacle is to prevent birds from flying into the glass and injuring themselves.

Before releasing birds into the enclosure, the glass should receive a thick coating of white or green water soluble paint. The thick coating is placed on the outside of the enclosure so the hummers cannot get to it. The coating still allows light penetration into the enclosure . When the birds are released into the enclosure they should have time to adjust to the boundaries. Generally after a week, a layer of the coating is removed and then another a week later. If all the birds are adjusting to the situation then the remaining layer of coating is removed from the glass. Interestingly hummingbird fledglings seem to be aware of the boundaries and have no problem with the glass after they fledge.

*Cage Size*

Cage size can vary depending upon the space available in the quarantine area. The minimum cage size would be 1.5 feet wide x 2.5 feet long x 1.5 feet high. This small cage would sit on a table or shelf. The bird should be able to fly back and forth in this cage and there should not be more than one bird to a cage. Hummingbirds should not be kept in a cage of this size for more than 60 days. A larger walk-in cage is adequate for one hummingbird and would be 3 feet wide x 12 feet long x 7 feet high. Larger cages could hold more than one bird but caution should be followed so as not to over crowd cages.

Two or three hummingbirds could be kept together in a cage that is 6 feet wide x 14 feet long x 7 feet high. A cage that could hold 8-10 hummingbirds would have the dimensions of 12 feet wide x 18 feet long x 8 feet high. Hummingbirds do not do well when overcrowded. The smaller cage (1.5 ft. x 2.5 ft. x 1.5 ft.) is not recommended for outdoors. If outdoor quarantine cages are utilized all cages must have mesh bottoms (to keep out predators) and adequate shade in the summer. All outdoor holding cages should have a tubular steel frame. Outdoor cages are not recommended for the winter and harsh climates. Another method that has proven successful for holding hummers for up to 80 days in isolation is using cubicles. Wild caught hummingbirds have been maintained in 12 inch x 12 inch x 12 inch cages for as long as 80 days effectively. Each cubicle has one bird and it is easy to monitor behavior and nutritional intake. The sides, top, and bottom are constructed of a solid material and the front is constructed of ¼ inch mesh. The cubicles can be stacked one on top of another or as a single unit. The cubicles should be maintained in an environmentally stable area.

*Seclusion*

Hummingbirds normally deal with threats or stressful situations by quickly darting away from the threat or flying straight up as they sometimes will do. When birds are in quarantine, care should be taken not to startle or create a situation where the bird would fly into the cage wire. The birds should be able to see anyone who approaches the cage. If walk-in aviaries are used the birds should be able to escape to the end of the holding cage away from the person. Allowing the bird ample room to fly within the holding cage will cause the bird to be less stressed. Outside aviaries can be covered on the sides and top with reed matting but areas should be left open for sunlight and air. If some covering is desired this should be done before the bird is placed in the cage.

*Substrate and Perching*

The floor of the indoor quarantine areas should be concrete that slopes to a drain. Nectar will drip on the floor and will need to be cleaned daily so ants are not attracted to the spills. Outdoor aviaries can be concrete or a soil substrate underneath the wire mesh bottom of the cage.

Perches should be thin natural wood and placed horizontally throughout the cage. Four or five perches should be ample for the smaller cages and more for the larger. The higher the perch the more comfortable the hummingbird will be. In general, you should have several perches per bird.

*Food and Water set-up*

Each hummingbird should have at least two feeders so the bird still has access to food and another feeder if problems arise with one of the feeders. A nutritionally complete and balanced diet is recommended. The packaged diet should contain carbohydrates, protein, fat, vitamins, and minerals. Foods that have not been tested and proved adequate for hummingbirds must not be used. Do not experiment with food for captive hummingbirds. Care should be taken to use only chemical free water for mixing with the nectar. Nectar in the feeders should be changed at least twice a day. Two-ounce *Perky Pet* (TM) feeders are easy to clean and work well for feeding. Feeders should be disinfected with bleach 10:1 (10 parts water & 1 part bleach) each time they are changed. The feeders should be rinsed well. Using sugar water as food for hummingbirds is not recommended for long term use. Sugar

water may be utilized as a temporary food but should not take the place of a nutritionally balanced nectar food source. Hummingbirds feeding on sugar water will also need a source of protein. Fruit flies (*Drosophila)* should also be provided for the birds. Fruit can be provided that attracts the flies if the quarantine area is outdoors or jars that contain flies for indoor quarantine can be used. Fruit flies can be bred in bottles and kept in an incubator. Fruit flies can be obtained from local Universities or purchased from Biological Supply Companies. There are different sizes of fruit flies that can be obtained in some areas. This may be important when you have different size hummingbirds in your aviary. Care must be taken to avoid attracting ants to the fly jars, fruit, or nectar feeders. Fly jars and fruit can be placed in the center of a pan that has a small amount of water in it to prevent the ants from getting to the fruit or fly jars. Vaseline or Tanglefoot can be spread on the wire or hook that holds the nectar feeder to prevent ants from crawling down onto the feeder. Do not use insecticide around hummingbirds.

*Misting and Bathing*

Hummingbirds love to take baths and they should be allowed to do so in quarantine. A shallow dish or rock with a small amount of water in it can be used for bathing purposes. A fine spray of water can also be used to allow the bird to bathe. Do not allow the bird to get too wet or it will be unable to fly. When using the water spray method allow the bird to retreat to a place in the cage away from the water if it desires to do so. Outside cages can be misted gently with a hose several times a day.

*Lighting*

Bright, artificial light is sufficient for indoor quarantine but the birds should be exposed to 12-13 hours of light. A dimmer should be used to warn the birds of lights-out an hour or so before turning off the lights. This allows the bird time to feed before roosting. It is not necessary to leave any lights on during the night.

*Special Needs*

If hummingbirds are kept indoors during the quarantine period you should move them to outside enclosures before placing them in outdoor aviaries. This allows the birds to acclimate to the outdoors once they are out of quarantine. As the quarantine period progresses the temperature should be graduated to match the temperature the birds will be introduced to after their release.

**Breeding cage set-up**

Most of the hummingbird breeding success in the United States has occurred in aviaries and exhibits. It can be difficult to breed hummingbirds in captivity. The birds must feel comfortable with their surroundings and the aviary or exhibit should resemble their natural habitat as much as possible. Hummingbirds do not pair off or form a pair bond like many birds during the breeding and nesting cycle. Separating pairs of hummingbirds for breeding purposes usually does not work. The males can be very aggressive and territorial and if separated with a female the two birds spend most of their time fighting. It might be better to keep the birds you are trying to breed in an aviary large enough to hold the desired breeding pair as well as the non-breeding hummingbirds. In this way the female can choose her nesting site within the aviary and the male she wants to breed with if you have more than one male of the same species. There will also be competition from the other males for the female and this would resemble a

natural situation in the wild.
There have been attempts to separate out breeding pairs and some of these attempts have been successful. An alternative to mixing males and females in the same exhibit is to separate each hummingbird into its own exhibit and only allow the male to have access to the female during nesting. Typically a male and female would be housed side by side and as the female completes her nest, the male is given access for short periods each day until she has laid her eggs. Females are then able to incubate and rear their young without disturbance from any other hummingbirds. This method is widely practiced in Europe and has been successful. With fewer and fewer non-native hummingbirds available in the U.S., this type of set-up may be useful in the future.

*Exhibit/Aviary breeding*
When female hummingbirds want to nest they will hover around trees, bushes, plants, and people looking for nest sites and nesting material. The birds will try out nest spots by sitting on objects before they start the nest construction. They may approach keepers or the public searching for hair, strings from clothes, and sweater yarn to use in their nests. You should provide the birds with animal hair, plant down, clothes dryer lint, cotton, lamb's wool, feathers, bark, moss, lichens, and spider webbing. Artificial spider webbing (Halloween type) is not recommended because the birds can get tangled up in it. There should be a healthy population of spiders living in your aviary to provide the natural spider webbing these birds need to nest successfully. The nesting material can be hung on the vegetation or placed on the ground for the birds to utilize. Hummingbirds will construct a small cup shaped nest with the materials you supply them with. Hummingbirds are very tolerant of humans around their nests but can get stressed out if the eggs or nest are approached too closely. Efforts should be made to give the birds the privacy they need to nest successfully.
It is recommended to have at least one male for every female in your aviary. If a female decides to nest and a male of the same species is not available she may breed with other males. This will encourage hybridization and is a problem with captive hummingbirds. Efforts should be made to avoid this problem. If the female builds a nest and lays eggs and there is no male of the same species in the aviary, you should assume that she bred with another male and remove the eggs or substitute non-fertile eggs in their place. This way she can incubate for a period of time before she abandons the nest. Otherwise she will continue to lay eggs to replace the removed ones and this can cause a drain on her health. Normally two eggs are laid 48 hours apart and the female usually starts incubating with the laying of the first egg. The eggs will hatch after 15-18 days of incubation depending upon the species. At the time of hatching it is important to supply the female with insects so she can feed them to the young. If nestlings are not growing properly it is probably because they are not getting the adequate amount of protein. Common predators on hummingbird nestlings are snakes, lizards, ants, rodents, and other types of birds. All efforts should be made to eliminate these type of predators from your bird aviary or exhibit if nesting is encouraged.

**Exhibit cage set-up**
*Cage size*

Hummingbirds do better if they are not over crowded. Care should be taken to allow hummingbirds in captivity to coexist with one another, set up territories, and breed. If birds are exhibited alone small exhibits like 4 feet wide x 8 feet long x 8 feet high are quite adequate. For example an exhibit that was 12 feet wide x 18 feet long x 8 feet high would be adequate for 8 to 10 hummingbirds. Larger aviaries can hold more birds. Keep in mind that the more hummingbirds you have in an aviary the more room you will need for them to establish territories and to nest. A good rule of thumb is to allow approximately 80 to 100 square feet per bird and at least two feeders per bird. When new birds are introduced into the exhibit you should add more feeders and gradually reduce to two feeders per bird as they settle in.

*Design and construction*

Outdoor aviaries are usually more desirable for exhibiting hummingbirds than indoor because of the natural situation. Care must be taken in the exhibit design so that the shape is varied and one hummingbird cannot dominate the entire aviary. Hummingbirds like to fly upwards when threatened and the height of the aviary should not prevent the public from viewing the birds. Exhibits with a height of 10 to 15 feet are more desirable for viewing the birds. Welded wire mesh that is 2 inch x 2 inch or 1 inch x 2 inch is good. ZooMesh (TM) can also be used for exhibit wire. The exhibit should have a tubular steel frame or an equilivent. There should be double entry and exit doors to prevent bird escapes from the exhibit. Plastic flaps and darkened doors can also help discourage bird escapes.

*Containment barriers*

Plants, railings, signs, walls, and rope barriers are recommended for keeping the public on the path in a walk-in aviary. Additional barriers can be installed during the breeding season to protect nesting females and their nests.

*Design concerns*

Smaller wire mesh (¼ inch x ¼ inch) and ZooMesh (TM) prevents most predators from entering the aviary. Smaller mesh can also exclude bees and wasps that can harass birds at the feeders. Glass can be used but care must be taken when adding new birds to the exhibit. The large glass greenhouse style exhibit at the San Diego Wild Animal Park is whitewashed before any new introductions. Circular or oval shaped exhibits help prevent one bird from dominating the entire aviary.

*Capture and handling systems*

Hummingbirds in small aviaries or enclosures can be caught up in the early a.m. before light. You must know where the bird is roosting and quietly approach the sleeping bird. If you gently place your hand or a net over the bird there is very little struggle. In larger aviaries a catch cage will have to be utilized to trap the bird. A cage of welded wire and a door that can be held open with rope or wire is an adequate trap. A feeder is hung inside the cage and when the bird enters to feed, the door is carefully closed to trap the bird. Once the bird is in hand care must be taken so the bird is not injured. Wings are easily damaged and the bird should be held gently but firmly to avoid injury. Wings should be against the birds' body and the bird cupped within the hand with the head protruding out. The bird should then be transferred to a soft mesh bag or meal worm bag and placed in a box for transport. If at all possible the

bird should not be in this bag for more than a few minutes before placing it in another cage. If the bird will be in the bag for more than 5 or 10 minutes the bird should be fed by hand. Hummingbirds should only be trapped and handled when absolutely necessary.

*Shelter requirements*

Outdoor aviaries should have a means to cover the top of the exhibit during harsh rain and snow storms. Tarpaulin and plastic covers are good materials for covering the top of aviaries. Outdoor aviaries are not recommended for northern latitudes in the winter. But southern latitudes within the United States can have outdoor aviaries during the winter if temperatures are not extreme. In these areas the aviary can be covered for storms that may occur during the evening when roosting birds are most vulnerable. If covering is used for the aviaries, do this during the daylight hours so roosting birds are not disturbed at night. Heat lamps can also be used during the winter for outdoor aviaries. Hummingbirds will not roost in front of the lamps at night but will utilize them during the day when temperatures are cool. One of the most important shelter requirements for hummingbirds are the plants and shrubs the birds will roost in. Plants should provide shade in the summer and cover during the winter for outdoor aviaries. Hummingbirds prefer plants that are dense and brushy during roosting.

*Substrate*

Hummingbirds spend very little time on the ground but do occasionally go to the ground to bathe. Sometimes nesting females will pick up small pebbles or dirt from the ground. A combination of sand, rock, gravel, and dirt make up a good substrate for the floor of the exhibit. Sidewalks within the aviary should be concrete.

*Landscaping*

The plants used in the exhibit should be carefully chosen for certain qualities. First, nectar plants should be chosen that provide a constant source of food for the birds. Second, non-nectar plants should be bushy to provide areas for roosting birds at night. Third, the larger trees and shrubs help to form territorial break-ups. Finally, public appeal should also be taken into consideration when choosing plants for the exhibit. The vegetation should not be so dense that the exhibit resembles a jungle but should provide adequate food, roosting, and nesting sites.

*Feed and water set-up*

Hummingbirds should be given a choice of foods within the exhibit. There should be a variety of nectar flowers that provide food throughout the year, a constant source of fruit flies and other insects, and nectar in feeders. See Quarantine Feed and Water Set-up for more information. Feeders should be placed throughout the exhibit at different heights. Allow at least two feeders per bird and more feeders if introducing new birds. Placement of feeders can be dependent upon the bird's territories. The 2-ounce Perky Pet (TM) feeders work well for the exhibit and are easy to clean. Bee guards should be used on the feeder and fine wire mesh (screen door mesh) can be glued on the sides of the bee guard to discourage bees from sticking their heads into the guard or feeder. Hummingbirds get most of their water from the nectar but will sometimes drink from standing water in the exhibit when temperatures are high. Glass test tube type feeders have also worked well as they are easy to clean but are delicate and

break easier than plastic feeders. A diet of nectar in the morning and sugar solution in the afternoon has proven successful over a long period of time but offering a balanced nectar diet the entire day is preferred.

*Bathing and or misting options*
Hummingbirds should be allowed to bathe daily. This behavior is important to their health and daily hygiene. This can be done by hand with a hose or by a water feature within the exhibit. Hosing vegetation several times a day allows the birds to bathe on the wet foliage. If a water fall or water feature is available the birds will take baths. The waterfall should have shelves where the water stands in a shallow pool and the birds can get into the water and bathe. Water should be free of harmful chemicals. Automatic water misters can be used but may cause damage to the plants if they receive too much water.

*Lighting*
Natural light is always better for the birds than artificial light. If hummingbirds are to be exhibited indoors sky lights are excellent. Other lighting is also necessary and the birds should be exposed to 12-13 hours of light. Light at night is not necessary.

*Special furniture/perches*
Hummingbirds like to perch on small thin branches. Dead snags, branches, and sticks make excellent perching items. If the plants in the exhibit are not providing enough break-up for hummingbird territories it may be necessary to put up wooden garden lattice. The lattice serves the same purpose as large trees or scrubs would for territory boundaries.

*Special behavioral enrichment items*
When hummingbirds are supplied with insects, nectar flowers, and nesting material they appear well adjusted and content in captivity.

*Display sites*
Outdoor exhibits should take advantage of the natural light when viewing hummingbirds. Iridescence on hummingbirds is best if viewed with the sun to your back. In this way you are not looking into the sun and you have the advantage of the light behind you as you view the bird. The exhibit should also be located in an area where there are less people and cart activity for evening events. This way the roosting birds are not subject to unnecessary noise or light at night when they are sleeping.

*Hiding structures*
Occasionally birds in the exhibit will have social problems with the other birds. During these times extra vegetation should be added to create hideout areas for the birds. The vegetation can be cut pieces of trees, branches, or scrubs. If the vegetation is piled up to create a hideout with a feeder inside, the hummingbird will use these areas until he can rejoin the population in the exhibit. When social problems arise, the troubled bird will usually return to an area over and over again to rest. This is a good time to set up the hideout in that area. The feeder should be placed just on the edge of the hideout so the bird

will see it. Once the bird regains confidence it will join the other birds in the aviary and the hideout can be removed.

## 3. BEHAVIOR AND SOCIAL MANAGEMENT

### General social considerations

Hummingbirds are aggressive, territorial, and not social. They can be a sensitive species to keep in captivity. Care must be taken to allow individual birds to set up territories as they would in the wild. When putting different species together you should take into account size differences, temperament, sexes, and compatibility. Larger birds are more aggressive than smaller ones, males are more aggressive and territorial than females, and some species may not get along with other species. Number of birds, cage size, feeders, roosting plants, nectar flowers, nest sites, and local weather conditions should be given careful thought. Overcrowding is not recommended because it creates stressful conditions in an exhibit. Plants and barriers can aid in the territory break-ups within an exhibit. An adequate number of feeders in the exhibit prevents tension and fights between the birds. Stress can cause weakness and disease.

### Introductions

Since hummingbirds are very territorial any newcomers are aggressively chased and harassed by the resident birds. It is recommended that several birds be introduced at a time in an exhibit or aviary. This way the chasing and aggression is dispersed among the new birds. New birds must be watched closely to assure that they are getting to feeders or flowers. Adding extra feeders on the day of the introduction gives the new birds a better chance at getting to the feeders and the resident birds have not had the chance to claim the new feeders. If one of the resident birds is aggressive in the exhibit it might help if this bird is removed on the day of the introduction. This gives the new birds an opportunity to settle into the exhibit and claim feeders before the removed bird is placed back in the exhibit. Even resident birds have a disadvantage when reintroduced into the exhibit after several days or so. It is recommended that new hummingbirds be placed in howdy cages for 1-3 days before being introduced into the aviary. This allows the new birds to locate landmarks, nectar, and flower sources. In addition it serves as an opportunity to allow the new birds to meet the established birds in a controlled situation.

### Effects of removing members of grouping

Hummingbirds will defend as large of a territory that they can. Removing birds from an aviary allows others to expand their own territories. If one bird is causing problems in an exhibit it is best to ride-out the bad period rather than remove the bird. Exceptions would be new introductions where the new birds might benefit initially from the other bird's temporary removal.

If conditions are too crowded in the exhibit removing birds will probably benefit the remaining birds. Young birds that have been hatched in the exhibit should be removed before the next breeding season. Male fledglings can be very aggressive to the older birds and the exhibit benefits from their removal. Removing the offspring also prevents inbreeding the next breeding season.

**Social spacing**
See Exhibit cage size above

**Setting up and managing an enrichment program**
Hummingbirds are motivated by food. By providing several sources of food for the birds to choose from you are providing enrichment. Feeders, flowers, and insects provide enrichment for hummingbirds. During the breeding season nesting material can provide another means of enrichment for the female hummingbirds.

**List behavioral indicators of stress, harassment or impending social changes**
*Torpor*
Torpor is a form of hibernation state hummingbirds utilize when stressed, during very cold periods, and when they have not obtained the necessary calories they need to survive daily. The birds are in a deep sleep where metabolism, breathing, body temperature, and heart rate are reduced. The bird does not respond to touch, light, or sound while in torpor. Torpid birds should be allowed to wake on their own in a reasonable time frame in the morning hours. If the birds do not wake during a reasonable time they should be placed in a soft cloth bag and placed in an incubator until they come out of the torpor. Once awake they should be hand-fed and placed in a flight cage for observation. If the bird is flying and feeding normally it can be returned to the aviary.

*Fluffed*
It is normal for birds confronted with strong winds or cold temperatures to fluff up their feathers. But if a bird consistently fluffs up when other birds are not doing this, the fluffed bird is suspect to be ill or in declining health. If you suspect the bird is not well you should catch it up and remove it from the aviary.

*Harassment*
If a bird is having social problems in an aviary it will be chased by the other birds and spend time hiding when not being pursued. If the bird is not defending a territory it may have problems getting to feeders. The harassed bird will perch with bill open and wings drooped. They may even go down to the ground in exhaustion or sit for long periods of time without any activity. If the bird does not obtain the food they need they will die. Efforts should be made to accommodate the bird in the aviary by setting up hideouts (see Exhibit cage hiding structures). If this does not improve the situation the bird should be caught up and removed from the exhibit. Because hummingbirds have a very high metabolism it does not take them long to decline if they are not able to feed regularly.

*Hanging on to the exhibit wire*
When a hummingbird constantly hangs on to the cage wire it is probably a response to stress. The bird is trying to escape the unpleasant situation. Efforts should be made to improve the conditions for the stressed bird. The bird must be able to feed without being harassed by other birds or it will decline rapidly.

*Birds trying to get out the doors of the aviary*
Stressed or harassed birds will spend more time around entrance and exit doors of the aviary. If given the opportunity these birds will get through the open doors and escape. Time should be taken to determine why the bird is stressed.

The above are good indicators of social, stress, or harassment problems with groups of hummingbirds. Unfortunately many hummingbirds do not physically show any signs of health or social problems and will die or disappear unexpectedly. Good observation skills and the more familiar you are with your birds, the quicker you will be able to detect problems. One method used to discourage hummers from attempting to escape through open doorways is to hang plastic chain from the door's threshold. This method greatly reduces the available open space while the door is open.

*Stereotypic behaviors*
Hummingbirds in aviaries will sometimes fly back and forth at the top of the structure for long periods of time. The flight pattern can be short or long within the aviary. Many birds exhibit this restlessness during migration and the behavior is only temporary. At other times newly introduced birds will exhibit the same restlessness until they have settled in and formed territories. Another behavior hummingbirds will exhibit when perched is to fly up a foot or so and return to the perch. This type of jump up and sit back down flight can be repeated for hours and is only interrupted by feeding or a territorial dispute. Many species of hummingbirds do this behavior in captivity. We are not sure what its significance is. For example, do hummingbirds get bored?

*Mixed species exhibits*
At the Arizona-Sonora Desert Museum we only exhibit hummingbirds that are indigenous to the Sonoran Desert in our Hummingbird Exhibit. We were careful to choose species that were similar in size and temperament. Since all the birds are native to this area they probably come into contact with each other in the wild. In reality they should be comfortable with each other in captivity too. We only exhibit hummingbirds in the Hummingbird Exhibit. In our Mixed Aviary we have many species of birds such as waterfowl, quail *(Odontophoridae),* doves *(Columbidae),* woodpeckers *(Picidae),* and passerines. We have successfully housed several species of hummingbirds with other species of birds. Larger species of hummingbirds also do well with other types of birds. Care should be taken not to exhibit hummingbirds with larger predatory birds such as cowbirds, roadrunners, etc. Roadrunners are known predators on hummingbirds. The San Diego Zoo and Wild Animal Park have been keeping their hummingbirds in mixed exhibits for many years which includes a variety of small species such as tanagers *(Tangara sp.),* honeycreepers *(Cyanerpes sp.),* manakins *(Pipridae),* cotingas *(Cotingidae),* small doves, waterfowl, etc. Representative species of all these groups have successfully reproduced in mixed exhibits that include breeding hummingbirds. At the San Diego Wild Animal Park we have exhibited over 30 species of butterflies with the avian collection without negative interactions between hummingbirds and butterflies. Aviaries with hummingbirds and butterflies can be very successful.

*Sequence of behaviors associated with reproduction*
In the spring hummingbirds will start exhibiting reproductive behavior. The males will become more

aggressive and fight often with other males in the aviary. Females will begin picking at plant down and will search for a nesting site. Our female hummingbirds at the Arizona-Sonora Desert Museum try to sit on camera tripods, camera straps, and the shoulders of the people in the exhibit. The females will start hovering around people and vegetation in the exhibit looking for nesting material. Territories may shift for both male and females during this time. Females do not always nest in their own territories and this may cause problems with the other birds. Males will spend more time following the females' activities while she builds a nest. During all these activities the exhibit may be unsettled by these behaviors.

*Managing social behavior over the course of years*

*Territory development*--Most hummingbirds set up a territory and defend it against other hummingbirds. In a captive situation hummingbirds can become very territorial because they cannot disperse and go somewhere else. Birds that have been in an aviary for a period of time will hold well defined territories and at times try to increase the territory size. Since the captive birds are not expending energy migrating or towards some of the other activities wild birds would be involved in they have a lot of energy to defend territories. This can be detrimental to newly introduced birds. Hummingbirds should be allowed to set up territories in captivity but well established birds should not be allowed to increase their territories at other birds expense. Two or three feeders are acceptable for the territorial birds and there will be some overlap of feeder sharing among some birds. If birds try to take over more than their share of feeders, some of the feeder locations should be changed and adjusted. The birds usually accept the changes but daily monitoring is required to avoid further problems.

*Nesting*--During the nesting season female hummingbirds should be protected from harm from the public. When the birds approach people looking for nesting material the first reaction to something buzzing around your head or face is to strike out or run. Docents, volunteers, or staff can explain to the public what the bird is doing. Birds can get hurt during this time and the more informed people are the less likely birds will be harmed.

*Behavioral development*

*Age at which dominance hierarchy is established*--Hummingbirds really do not establish a dominance hierarchy as such but the more aggressive birds will establish well defined territories. Young males can be far more aggressive than the adult males and an aviary that has both young and old males can be explosive. Young males are constantly challenging the older more established birds. Young males and females usually do not establish territories until they are one year old or ready to breed. Females are territorial but less so than the males. Also young females do not create the problems that the young males can in an aviary.

*Age at which females and males sexually mature*--Our male and female fledgling hummingbirds at the Desert Museum Hummingbird Exhibit have been sexually mature at the age of one year. We even had a female Costa's Hummingbird build a nest, lay eggs, and raise 2 young before she was a year old. Breeding before the age of one year is probably not normal for hummingbirds but you should be aware that it can happen. Most male hummingbirds are at least a year old before they have adult plumage.

Their adult plumage is necessary to court females during the breeding season.

*Age of dispersal*--Once young fledgling hummingbirds start fighting with the adults in the aviary you should remove them. Competition, fighting, and territorial disputes can stress the adult birds. Male fledglings can be very aggressive and it seems that their whole purpose in life (so far) is to harass the adults. Removing them also prevents inbreeding.

## 4. REPRODUCTION

### General considerations

Keeping hummingbirds in captivity is not an easy task and it is even more difficult to maintain a breeding program. To have a successful breeding program hummingbirds need to be allowed to set up territories, co-exist with one another, and nest. They should be able to act like hummingbirds and carry out their natural behaviors as they would in the wild.

*Preparing for breeding*

Females ready to breed get in a nesting mode and their behavior indicates their desire to nest. They begin to hover around vegetation and pull at pieces of plant fiber. They will also hover around people looking for nest material. At this time you should place animal hair, plant down, cotton, lambs' wool, clothes dryer lint, sweater yarn, and thread in the enclosure for the birds to use. The birds will combine these materials with spider silk to build their nests. There should be a good healthy population of spiders in your aviary to provide the spider silk the birds will need to build their nests. You should also have an adequate supply of fruit flies for the nestlings. Females will feed fruit flies and other small insects to the nestlings during the nesting period.

During the breeding period male hummingbirds will become more aggressive in your aviary and compete with the other males for the female's attention. You should pay close attention to territorial problems within the aviary. You should also have barriers that can be put into place if the nesting females are too close to paths or the public. Female hummingbirds can be very tolerant of activity around their nests but there should be some distance between their nests and the public. The birds should be able to nest without being harassed by photographers and people who want to look in the nests. If people are kept several feet away from the nest it should be adequate but each nesting bird will have to be evaluated for its sensitivity to disturbances around the nest. Photographers should not be allowed to use camera flashes on the nest. Adult females can leave the nest if disturbed but the nestlings cannot.

*Timing of breeding and molt*

Most North American Hummingbirds breed in the spring and summer but captive birds can nest earlier. If the aviary is outdoors the birds will have nesting periods similar to what they would do in the wild. Indoor aviaries may have some variance because of the artificial conditions. Anna's (*Calypte anna)* is one of the North American species that will nest in the winter months. In the wild this species can start nesting as early as November and continue to March. Many North American Hummingbird species can start the nesting process in January and nest until August.

South American species of hummingbirds can nest at any time of the year.

Many female hummingbirds molt just after the nesting period. Some females will start molting before their last clutch is weaned. In the wild many North American Hummingbirds molt on the wintering grounds and before or after migration. During molt the birds will require a lot more protein in their diet and a good supply of insects will help the birds molt properly. Most birds molt the flight feathers first and then the body. Males will molt gorget feathers last and before they breed.

*Setting up pairs / Identifying pairs*
Hummingbirds do not pair up like many other species of birds. The males will breed with as many females as they can and the females will have the full responsibility of the care and raising of the young. You should have at least one male for every female in your aviary of the same species to avoid hybridization. The females will nest regardless of whether a male of the same species is present or not. In the United States most hummingbird breeding in captivity has taken place in an aviary or exhibit situation. As mentioned, European collections generally set up breeding enclosures for single birds and only allow a male and female to mix for copulation. This is a very controlled situation that may not be the best for exhibit purposes but could be used to maximize reproduction in an off' exhibit setting.

*Type / description of nest used*
Hummingbirds typically make a small cup-shaped nest. They use plant down, animal hair, yarn, cotton, and other soft material they can find. They use spider silk to bind the nest together. They will construct the nest on a branch, leaf, or platform and the nest can be several feet off the ground or at the top of the aviary. If the nests are falling apart when they are complete or the eggs fall out, you may have a lack of spider silk in your aviary. Hummingbirds cannot make good nests unless they have the spider silk to bind the nest together. Birds will reuse nests so do not remove the nest until the nesting season is complete. Nests left in the exhibit make good interpretive items. In some cases female hummingbirds may accept an artificial nest.

**Monitoring and managing reproductive activity**
Hummingbirds will be successful at nesting if they are not harassed during the process. The best rule of thumb is hands off. If an egg falls out of the nest it is best to let the female re-nest or try again. Most eggs do not survive a falling without getting broken or cracked. If a nestling falls out of the nest it should be placed back in the nest. Sometimes females will detect an unhealthy nestling and toss it out of the nest. If you put the nestling back in the nest and it ends up on the ground again the female has probably purposely tossed the chick out of the nest. If the nests comes apart with nestlings in it then you can construct an artificial nest in its place or repair the old one. Either way the nest should be placed in the exact spot the old one was. Hummingbirds are very site specific for their nests and will not go to a new location even if the nestlings are in the new nest.

*Chick growth and development*
Most North American species of hummingbird nestlings grow quickly with the proper care and many are ready to fledge by 20 days and on. If nestlings do not develop properly it might be due to the lack

of insects, the mothers' health, or cold temperatures. All these factors will slow the growth of nestlings or cause them to decline or die. When hummingbirds hatch they have a few down feathers along the major feather tracts on both sides of their back. Their tiny bodies look like small raisins with a tiny bill and large head. Their eyes are closed and they do not open for about a week. They are totally dependent upon their mothers for their survival. She will brood them for about 10 to 12 days until they develop enough feathers to regulate their own body temperature. During the day, the mother feeds her nestlings every ten to fifteen minutes. She regurgitates insects and nectar from her crop and transfers it to the crops of the young. The nestlings usually make no sounds in the nest if they are healthy and well fed. A vocal nestling is ill, frightened, or not getting enough nourishment.

As nestlings get larger they spend more time at the top of the nest watching life outside the nest. The nestlings should be fully feathered by two weeks of age. By this age they are very alert and aware of other birds in the area. They know when their mother is close by and will react by gaping when she comes close to the nest. Another adult female bird will not solicit the same response. At 19 or 20 days old the nestlings sit on the edge of the nest and practice flapping their wings in preparation of fledgling. When the mother comes to the nest to feed them during this time they will usually hop back down in the nest to be fed.

*Parental care pattern; feeding pattern; diet changes related to nestlings*
After hatching the female will continue to sit on the nest and brood until the nestlings have grown in enough feathers to regulate their own body temperature. The female will toss the egg shells out of the nest after hatching. She will only get off the nest to feed herself and her young, chase intruders, and bathe. After 10 or 12 days she will spend most of the day off the nest collecting food for the nestlings. During the first two weeks she feeds the nestlings almost exclusively insects since they are important to the young bird's growth. After two weeks the nestlings have grown in most of their juvenile plumage and the mother will start feeding the young more nectar. She will continue to feed insects even after the young have fledged but not at the rate she fed them when they were less than two weeks old. If the nest gets wet during rain storms or cold temperatures chill the nestlings, the female will brood the young during these periods. Also she will shade the nest if temperatures are high or the nest is in the sun and the nestlings appear uncomfortable.

*Age of fledgling and sexual maturity*
Nestlings usually leave the nest 21 to 30 days after hatching. Several days before fledgling the nestlings will sit on the edge of the nest throughout the day. When they get the "wild-eyed" look they are close to fledgling. They will practice flapping their wings as they hold onto the edge of the nest. If the nest has two nestlings they will fledge in the order they were hatched. Fledglings have small bills and short tails. In the first few days after fledgling the youngsters do not move very far from the nest area. They are very vocal at this time and beg to be fed when their mother is near. Fledglings will start flying more as the days pass and their first attempts at feeding are at flowers, if these are available. Other adult hummingbirds in the aviary usually do not harass the fledglings when they are young since the young birds do not pose a threat to the older birds. Females will wean their fledglings from a week to several weeks after they leave the nest. If a female is building another nest or wants to lay another clutch she

will wean her young at an earlier age. Some species such as the Sparkling violet-ear will re-nest in less than a week after her chicks have fledged. The female will re-use her same nest and to continue to care for the chicks and incubate a new clutch at the same time. On the other hand if the female is finished with nesting she will care for her fledglings longer. Young male fledglings become very aggressive soon after they are weaned. The young males can cause problems in the aviary for the adult birds. Young hummingbirds reach sexual maturity by the age of one year and usually have their adult plumage at the same time. Some males may achieve their adult plumage before they are one year old.

*Alternative rearing method for mixed species exhibits*

At the San Diego Zoo, most young hummingbirds are removed from the main exhibit with their female parent just prior to fledgling. This is accomplished by cutting the branch that supports the nest and chick and placing it in a "howdy cage"- a small portable cage measuring 30 inches x 18 inches x 18 inches. Soon after, the female will enter the cage to feed the chick and the door is closed. The cage is then moved to an off-exhibit area and placed in a planted weaning cage measuring 10 feet x 6 feet x 8 feet high. After about one hour the female is given access to the weaning cage. She will continue to feed the chick in the howdy cage until it fledges, usually within one or two days after the move. This will give the chick the safest environment possible for fledgling and to give the female a quiet place to finish the rearing process free from the stress of a mixed exhibit.

**Artificial Incubation**.

Because of their small size, hummingbird eggs would be difficult to handle and incubate. It is best to let the female hummingbird incubate her own eggs.

**Hand rearing**

At the Arizona-Sonora Desert Museum Hummingbird Exhibit our birds do a great job of raising their young and we have not had to intervene very often. If a nestling falls out of the nest we put it back in. Occasionally a nest will fall apart with nestlings in it and we provide an artificial nest or repair the bad one. Most hummingbirds are very tolerant and accept the help. One female Broad-billed abandoned her nest when the two nestlings fell to the ground and the nest fell apart. All of our attempts to recreate the nest in the same place failed and she would not return. The nestlings were cared for by Museum staff until the female built another nest and laid more eggs. Once the female had incubated the eggs for several days, the eggs were removed and the nestlings placed back in the nest. The female actually accepted the nestlings. She was a little shocked at the change but readily accepted the older young. All attempts should be made to allow the females to raise their young.

**Contraception techniques**

Hummingbirds should be allowed to nest in captivity since there is so little breeding of captive birds in the United States. The offspring can be sent to other qualified institutions. Non-fertile eggs should be saved for future use if you do not desire a female to nest. This way she can go through the nesting process while you provide her with non-fertile eggs to incubate. You can remove her own eggs and replace with the non-fertile. This will allow her to incubate. She will eventually abandon the nest when the eggs fail to hatch but this will let her to go through part of the nesting process. Removing nests does

not always work well. I have seen females continue to build new nests each time a nest was torn down and the females end up being exhausted by the extra nest building. It usually does not work either if the male is removed from the aviary to prevent copulation because the female will only breed with other males. Of course if there are no males in the aviary at nesting time, the female can still build a nest and incubate her eggs without the worry of hatching.

## 5. NUTRITION

### Enclosure management

*Feeding single or mixed species enclosures*

When feeding hummingbirds in either single or mixed species enclosures, you should offer the birds several sources of food. Hummingbird pollinated plants that offer nectar throughout the year will provide an almost continuous source of food for the birds. In addition to the nectar plants you should provide artificial feeders with a nutritionally balanced diet for the hummingbirds. The complete food for the captive hummingbirds should include essential carbohydrates, protein, fat, vitamins, and minerals. The nectar should be mixed with chemical free water. You should change the feeders at least twice daily and disinfected with bleach each time they are changed. Fruit flies *(Drosophila melanogester)* can be bred and fed out to the hummingbirds on a daily basis. During times of molt or nesting the birds will require more protein in the form of insects. If your aviary is outdoors and the mesh allows insects to enter, this will provide a source of food for the birds too. You can purchase fruit flies and fly food from Carolina Biological Supply Company**.** Mixed species enclosures should have enough nectar feeders for the hummingbirds and other nectar birds without creating feeding problems with the mixed species.

*Number of times fed per day*

Feeders that contain nectar should be changed in the morning and afternoon. If the temperatures are extreme you may want to change the feeders three times a day. Fruit flies should also be offered in the morning and additional flies in the afternoon for molting and nesting birds.

*Feeding locations*

Feeders should be located throughout the enclosure for captive hummingbirds. Feeders should be distributed at all heights within reason for the Keepers. It may be necessary to place some of the feeders within the vegetation if hummingbirds are comfortable feeding at these sites. Caution should be kept when placing feeders where the public can get close to the feeding birds. Young children might be tempted to swing or grab feeders and hummingbirds that are close to visitor paths.

Fruit flies that have been bred in jars can be placed on the ground in a cup with water to prevent ants from crawling into the jar. Birds in small enclosures should be allowed to fly to an area within the enclosure away from Keepers while the feeders are being changed.

### Diet and feeding

There are several excellent packaged nutritional, balanced nectar diets that can be feed to

hummingbirds. The diet should contain carbohydrates, protein, fat, vitamins, and minerals. The most important thing is to feed the birds a good balanced food. Change the feeders two to three times per day. Disinfect the feeders with bleach 10:1 (water to bleach) between uses and rinse well. Hang the feeders to dry.

Fruit flies *(Drosophila melanogester)*--Flies can reproduce in bottles and be kept in an incubator inside the service area. Fruit fly bottles should be cleaned and restarted every two to three weeks. Disinfect the bottles well after use and the foam stoppers should be soaked in alcohol between uses. Use fresh packets of yeast each time you make up new fly bottles. Cultures of fruit flies can be kept I temperate climates by placing a heatlamp over a bucket of fruit. A screen of ¼inch x ¼inch mesh allows the fruit flies to leave the area and precludes the birds from getting to the rotting fruit.
Flies, fly food, and supplies can be purchased from Carolina Biological Supply Company, 2700 York Road, Burlington, North Carolina 27215. (1-800-334-5551)

**Nutrient composition**
Recent research has shown that the ideal adult hummingbird diet is from 1.5 to 3% protein. Carbohydrate content should be no greater than 89 or 90%. Care should be taken to insure that the iron content of commercial foods for hummingbirds is low to avoid iron storage disease. It would be good to have a laboratory analysis performed annually on the commercial food being fed to hummingbirds. It is not unusual for a reputable manufacture to change the composition of the commercial diet and not contact those using the product. The commercial diet should contain a balance of carbohydrates, protein, fat, minerals, vitamins, and iron levels should be low.

## 6. HEALTH ISSUES

**General health monitoring**
*Stress factors*
To minimize aggression and stress in your enclosure, you should choose species similar in size and temperament and limit the number of males of the same species. Do not overcrowd the enclosure with hummingbirds and the birds should be able to set up territories and nest. Poor management practices and environmental factors could also cause stress to captive hummingbirds. Newly introduced birds to an aviary should be observed carefully to see that these birds are getting to feeders on a regular basis. New birds will be chased by the resident birds and it is important that the newcomers be allowed to feed undisturbed.

**Major disease problems and common injuries for the species**
*Medical problems*
Tapeworms can be found in the small intestine of birds that eat arthropods. At the Desert Museum some of the hummingbird necropsies showed that the birds had a severe intestinal infestation of tapeworms. Many of these birds had lived in the exhibit for five to ten years. Many of the older birds showed no sign of tapeworm infestation. It is hard to say what is normal or not.
None of the captive hummingbirds have ever been treated for tapeworms at the Desert Museum. I do

not think there is a current protocol for treating this condition for hummingbirds. You should consult with your zoo veterinarian if tapeworms appear to be a problem with your birds.

Two of the hummingbirds at the Desert Museum showed avian pox lesions around the beak after they died and a necropsy was performed. We were unaware of this while the birds were still living. These incidents of pox were in the late 1980's and a few years after we opened our Hummingbird Exhibit in 1988. We have never had an incidence of pox among our hummingbirds since this early time. It could have been that these birds had the virus when they were collected from the wild and it was not obvious to us. The pox virus can be introduced by new birds, wild birds, or insects.

Stress and sometimes a bad batch of food can also create problems like fungus in the throat of some captive hummingbirds. The birds will keep the tip of the tongue outside the bill. A medication called Nystatin has been used by some institutions to treat the fungus problem and the birds seem to be cured within one or two days.

*Common injuries / problems*

Wing injuries pose a major problem for hummingbirds. The bird should be very gently examined with the least amount of stress to the bird. The bird should be given a nutritionally balanced diet or Lactated Ringers if it has not eaten or looks fluffed. If the bird is unable to fly or allows one wing to droop, there is probably a wing injury. A veterinarian should do the examination. A broken wing can begin to set as soon as 24 hours so it is important to treat the bird as soon as possible. When wrapping the wing care should be taken to avoid damaging flight feathers. If the bird shows no improvement after the wrap is removed from the wing it just may take more time for the bird to fly. The bird should be given time to heal and this may take weeks or months. If after a period of time the bird shows no improvement, it may not fly again.

Head injuries can occur when birds run into doors, walls, or glass. If the bird is conscious you can feed it and watch for additional problems. If the bird can perch place it in a cage with several feeders. One feeder can be set up in front of a perch so the bird can reach it without flying and the other feeder can be placed so the bird will have to fly to get to it. The bird should be released if it can fly and feed normally. More serious head concussions should be treated by a veterinarian.

It helps to keep the bird warm and you may want to use a heat lamp or heating pad for birds that are sleepy or unconscious. Care should be taken not to put the heat lamp too close to the bird and the heating pad should be on low with a towel or cloth between the bird and pad.

Bill injuries should be treated by a veterinarian.

Hummingbirds use torpor to deal with stress or a means to survive when they have not obtained the calories they need to survive. Torpor is a hibernation state and the body temperature, breathing, and metabolism is greatly reduced. A torpid bird should never be forced fed. A warm environment such as an incubator will help to bring the bird out of the torpor. Be sure to place the torpid bird in a bag when you place it in an incubator. Heat lamps and heating pads can help too but remember to keep the bird in a box, aquarium, or cage so the bird is contained when it comes out of the torpor. Once out of the torpor the bird should be fed and if it can fly normally returned to the aviary. Torpid birds that are perched will not easily let go of the perch. Care should be taken not to force the feet free and the best

thing to do is to take both the bird and perch to the warm environment where it can awake on its own. Injury to the feet could occur if you try to pry the toes loose from their hold of the perch.

*Behavioral manifestations of illness*
Sick or ill hummingbirds will fluff, go into torpor, nod their heads, or appear sleepy. They should be fed, given warmth, and observed closely. Seek a veterinarian's advice if the birds do not improve.

## 7. TRANSPORT AND HANDLING

There are several airlines that regularly ship birds. American, Continental, and Delta have been used to ship hummingbirds but you should check with the airlines since regulations or shipping requirements can change. Hummingbirds can be shipped in two ways. Some of the airlines will allow you to carry the birds with you on board if the birds are contained in a carrier that will fit underneath the seat. You will have to purchase a ticket for the birds and they usually limit it to four or five birds depending on the airline. The other shipping method is to send the birds by freight as you would domestic pets. You can usually ship counter to counter and the birds can be picked up at the airline freight counter in the receiving city.

**Shipping container**
A wooden box (14 inches long x 12 inches wide x 6.5 inches deep) with a handle and several small windows covered with mesh for air can be used to carry the birds with you. The top of the box opens and the inside bottom of the box should be soft to lay the birds on during the shipment. Before building such a box always check with the airlines for size specifications. The birds are kept in a soft cloth mesh bag so the bill is readily available for feeding. The birds will have to be fed every 45 minutes throughout the flight. We have used this method of shipping hummingbirds at the Desert Museum for many years and it works well. **Do not take the birds through the x-ray machines at check points in the airport!** Ask airport officials to hand check the box because you have small live birds. Hummingbirds subjected to large amounts of radiation could be harmed or killed.
Also small or medium sky kennels can be modified to ship hummingbirds by air. The windows must be covered with mesh and small perches wired to the inside of the kennel so they do not come loose during shipment. Feeders can be tied to the insides of the kennel and it is recommended to have several large flat saucer type of feeders at the bottom of the kennel for the birds to utilize too. This way the birds have a food source on the bottom of the kennel in case some of the nectar spills out of the top feeders during shipment. The birds can fly free inside the kennel. Do not put more than two to three birds together in one kennel. Most international shippers send birds in small groups of two to three in the same compartment (see also IATA regulations, page 183, 28$^{th}$ edition).

**Shipping preparations**
If shipping hummingbirds by air in a sky kennel, first call the local freight office to make arrangements. There are also temperature restrictions when shipping live animals so always check to see what the regulations are for the airline. The norm required for temperatures is usually above 45°F and below

85°F. The temperature may be within the range in your location but not within the guidelines at the receiving city institution. After making arrangements you will be given an air bill number. Most freight offices require a credit card if you do not have an account with the airline. Use airlines that will get the birds to their destinations the same day. Non-stop flights are always the best if you can arrange that type of shipping. Try to ship early in the morning so the birds will get to their destinations by the afternoon or early evening. Evening shipping is not recommended. Remember the birds have a limited amount of nectar and they should only have to feed on this for one day. The birds should be put in the shipping crate on the morning of the shipment and the food made fresh that day. If hand caring the birds with you on the airline you should have freshly made up food, feeders, dry nectar to mix later if needed, and a cloth or paper towels to clean up nectar spills. It is best to check all baggage at the check-in counter except for a carry-on to hold the nectar and feeders. You do not want to be fumbling around with luggage when you have a box of hummingbirds you are caring for. Have someone from the receiving institution meet you at the airport when you reach your destination. This way you can let them deal with the birds while you get your luggage or vice versa.

**Feeding during shipment**

If the birds are hand carried on the plane with you then you will need to feed the birds every 45 minutes or so. The birds should be taken out of the box and gently handled while feeding. Since the birds are in a soft mesh bag the birds' bill can easily be maneuvered for feeding. You may have to expose the birds to some sunlight if they refuse to eat and it helps to sit next to a window on the plane. Most birds feed readily but it may take others longer. Be patient when a bird does not feed and place it back in the box for a later feeding. Handling the birds as little as possible will reduce the stress. If the birds do start to stress they may go into a torpor. Taking them out of the box and holding them on your lap while keeping them in the mesh bag may help. You should try to keep them as warm as possible during this time. You can also gently blow on them and use your voice to waken them. If these attempts do not work it is best to keep the birds in the box and quiet. Once you have reached your destination you can continue to work on getting the bird out of the torpor. **Remember do not try to force feed a torpid bird.**

Birds shipped in the sky kennel will have access to food the entire time they are in route to their destination.

**Shipment follow up**

If hand caring birds you should immediately get the birds into flight cages as soon as you reach your destination. It is important that the birds be allowed to fly and feed before they go to roost. You may have to add some artificial light to allow them to feed if they arrived after dark but it is important to make sure the birds are doing OK. Birds in sky kennels should also be removed and placed in flight cages as soon as possible. Once the birds have had 20 to 30 minutes to feed you can allow them to roost for the evening.

If the birds were shipped by air freight have the receiving institution call you when the birds have arrived. This way you know the birds have arrived safely and are not sitting at an airport where they did not make their connecting flight. This did happen once for a Desert Museum shipment. The sky kennel with

the hummingbirds was taken off the plane along with a kennel of hunting dogs and airline officials forgot to put both the hummingbirds and dogs back on the flight. The airline realized their mistake and got the birds and dogs on the next connecting flight to their destination. The birds arrived four hours late and aside from being tired they were fine.

## 8. EXHIBITION AND INTERPRETATION

### Appropriate exhibit formats / features

*Exhibit formats*

Exhibit design and sizes were discussed earlier in Housing and Enclosure Requirements. I do not think there is a perfect design or shape for exhibits housing hummingbirds. Exhibits should be designed to allow the expression of natural interactions between the birds and the plants they pollinate. The most important thing is to remember to not over crowd the birds and give each bird room to set up territories and nest. Hummingbird iridescence is best viewed with the sun behind the viewer so that you are not facing the sun. Walk-in aviaries should be large enough to allow the birds to get away from visitors if the birds feel stressed.

*Exhibit features*

Hummingbirds love to bathe so waterfalls or water features are recommended. Plants should serve several purposes in a Hummingbird Exhibit like perches, roosts, feeder sites, food, bathing platforms, nesting sites, nesting material, and territorial separations.

Glass should not be used as wall barriers for the exhibit. Hummingbirds in the wild regularly run into windows and it can be deadly to birds in captivity.

Entrance and exits should be designed to allow visitors to pass through them easily, while preventing birds from escaping. There should be two sets of doors and plastic flaps or something similar. Benches should be provided for visitors to enjoy the birds and a path that allows those people who only want to pass through the aviary to get in and out quickly.

### Activities for public involvement

Hummingbirds are a popular attraction for visitors. It is common for hummingbird enthusiasts and birders to want to identify the birds. Identification tiles or plates will encourage visitors in the exhibit to spend time identifying the species of birds. Keepers, Docents, and Volunteers can greatly enhance the visitor's time spent in the exhibit. Old nests and eggs can be displayed in such a manner that they add to the experience. Docents can hand carry the nests and eggs to let the public get a closer look at the items. These activities will also take some pressure off the nesting birds during breeding season. One of the problems we have had the Desert Museum is that visitors try to look in active nests to see the eggs and nestlings. The hand held nests and eggs seem to satisfy most of the people and they usually will not bother the actual nesting birds. Workshops for Docents to help them with hummingbird identification will make them more confident. Well trained Docents will be eager to spend time in the exhibit helping visitors identify and learn their hummingbird species. Hand held nests and eggs should be kept in plastic or glass containers that are easily viewed by the public but are also protected from fingers and hands.

**Biological points of interest / interpretation**

Hummingbirds have numerous fascinating biological aspects that should be emphasized in an exhibit and used for interpretive purposes. For example heartbeat, respiration, body temperature, metabolism, torpor, wing beats, weight, iridescence, etc. should be explained with signage inside the exhibit**.** Comparing a hummingbird's metabolism with that of a human always thrills the public. Many people think that hummingbirds cannot possibly migrate on their own and must ride on the backs of geese! The courtship displays are incredible and should be interpreted. Nesting biology should be described and explained in terms that the average person can understand it. Feeding hummingbirds and attracting birds with gardens are topics that would interest many homeowners, students, clubs, and the average citizen.

## 9. DATA COLLECTION

**Program review**

*Husbandry practices*

Hummingbirds thrive in captivity if good husbandry practices are followed. If an exhibit has been opened for a long period of time it is clear what works and what does not work in regards to hummingbirds. Successful husbandry practices can be tracked. If birds are not living for more than a few years in an exhibit then there are problems with the current husbandry practices. Hummingbirds can live as long as 12.2 years in captivity (personal observation) if they are cared for properly. Some birds will not live this long in captivity but a well cared for hummingbird exhibit should have birds that live for at least 6 to 8 years. Good records should be kept on all the birds when they come in and up to the day they die. Keeper, Docent, and visitor observations are very important. Necropsies should be performed on all dead birds. Daily the birds should be inventoried and any behavioral changes or observations recorded. Excellent records are always very valuable and can be a great help for day to day husbandry or for future reference.

*Breeding and nesting activity*

If you are fortunate to have species of hummingbirds that nest in your exhibit you should keep immaculate records on the activities. There are many gaps in our knowledge of hummingbird breeding biology. Even though the birds are captive the information is valuable to science and research because it indicates what hummingbirds are capable of when conditions are ideal. Also your records and information can be compared or would be helpful to other institutions that would like to breed hummingbirds. A word of caution is that many outside researchers will want to research the captive hummingbirds. Research that requires birds to be handled or manipulated while they are in captivity will undoubtedly cause stress for the birds. The captive birds are already facing stress from living in close proximity to other species they may not choose to be around in the wild. Research is good and captive populations of animals can provide valuable sources of information to the researcher and the scientific world. But the animal should not be stressed or sacrificed for research purposes. Behavioral research involving observation causes no stress to the captive bird. Hummingbirds should not be handled more than is absolutely necessary. Keeping good records during nesting is data that can be used later for research purposes. The best approach to take in regards to research is to make sure that everyone

involved is comfortable with the project and the birds will not suffer or stress out with the methods taken to achieve a result.

## REFERENCES

The following list is intended to provide some general references on the care and breeding of hummingbirds in captivity. The articles in German usually have a short English summary. This does not represent a complete list and any readers that know of other good references are encouraged to contact Karen Krebbs, Dave Rimlinger, or Michael Mace.


Bieda, Lori (1993): Humming to the Tune of Man. Watchbird, Vol. XIX, No. 6.

Bitterwolf, Jürgen (1984): Meine Käfig-und Volierenanlage für Kolibris (My Cage and Enclosure Exhibit for Hummingbirds). Trochilus 5:2-29.

Brice, A.T. (1991): Protein Nutrition of Captive Hummingbirds, Proc. of the Ninth Dr. Scholl Conf. on the Nutrition of Captive Wild Animals.

Elgar, Rod J. (1987): Anmerkungen zur erfolgreichen Brut der Lesson-Amazilie *Amazilia amazilia amazilia* (Lesson 1826)(Notes on Successful Breeding of the Western Emerald Hummingbird *Amazilia amazilia amazilia).* Trochilus 8:3-36.

Flanagan, Amy Kendall (1998): Delicate nests: Breeding the purple-collared woodstar. AFA Watchbird, 25(4): 40-41.

Gloge, Richard (1987): Haltung und Zuchtversuch von Juliakolibris (Damophilia Julie) im Augsburger Zoo (Husbandryand attempt at breeding Julie's Hummingbird *Damophilia Julie* at Zoo Augsburg). Trochilus 8: 37-76.

Grogan, Ivor (2000): Breeding the white-breasted amazalia *Amazalia amazalia leucophoea*. Avicultural magazine Vol. 106, No. 4.

Hüning, Werner (1985): Die Zucht von Colibri coruscans in der Freivoliere (Breeding Sparkling Violetear *Colibri coruscaans* in an aviary. Trochilus 6: 41-70.

Kaiser, Martin (2000): Langjährige Zuchterfolge bei Veilchenohrkolibris (Colibri coruscans) und Schwalbentangaren (Tersina viridis) im Tierpark Berlin-Friedrichsfelde (Long Term Breeding Success in Sparkling violetear *Colibri coruscans* and Swallow tanager *Tersina veridis* at the Tierpark Berlin-Friedrichsfelde. Milu berlin 10: S. 48-62.

Krebbs, Karen (1992): Hummingbird breeding and nesting success at the Arizona-Sonora Desert Museum. American Association of Zookeepers. Western Regional Conference, Tucson, AZ.

Krebbs, Karen (1992): Four years of hummingbird breeding at the Arizona-Sonora Desert Museum. Animal Keepers Forum. November.

Krebbs, Karen (1997): The" Hummingbirds of the Sonoran Desert Region" Exhibit. The Journal of the American Association of Botanical Gardens and Arboreta. Public Garden. Vol. 12, No. 4, Oct.

Krebbs, Karen (1999): The Arizona-Sonora Desert Museum's Hummingbird Propagation Program. International Wildlife Rerhabilitation Council 22nd Annual Conference Proceedings. Tucson, AZ. October.

Mobbs A.J. Hummingbirds

Palmer, Barbara & Krebbs, Karen (1989): The creation and operation of a native hummingbird exhibit. 15th National American Association of Zookeepers Conference, Syracuse, New York

Scamell, K.M. (1966): Near Misses with Violet-eared hummingbirds (Colibri coruscans). Avicultural Magazine. Vol.72, No.6.

Scamell, K.M.: Breeding the Violet-eared hummingbird (Colibri coruscans). Avicultural Magazine. Vol. 73.

Schürer, Ulrich (1983): Zur Geschichte der Kolibrhaltung in Europäischen Zoologischen Gärten (On the History of Hummingbird Husbandry in European Zoos). Trochilus 4:2-31.

Schürer, Ulrich and Bock, Jürgen (1983): Haltung und Zucht des Jamaikakolibris, Trochilus polytmus polytmus (Linné, 1758) (Husbasndry and breeding of Red-billed streamertail Trochilus polytmus polytmus). Zool. Garten N.D. Jena 53, S. 169-195.

Strehlow, Harro (1985): Zur Frühgeschichte der Kolibrihaltung in Europa (An Early History of Hummingbird Husbandry in Europe). Trochilus 6: 71-109.

Stoppelmoor, Greg (2000): Captive Breeding of the Sparkling violet-ear Hummingbird. Watchbird, January/February, 52-54.