

NUTRITIONAL CONSIDERATIONS FOR MAINTAINING AQUARIUM FISHES

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Abstract

A broad spectrum of nutritional issues faces aquariums. Although some of these issues may appear very basic, such as maintaining adequate food supplies or ensuring their adequate distribution and consumption within an exhibit, there is an underlying complexity created by the interrelationships of many nutrition-related issues within aquatic systems. This paper briefly describes several of the most prevalent issues facing nutrition of aquarium fish today, their relationships, and future challenges in the field.

Mixed Species Exhibits

Aquariums, much like zoos, rarely maintain single species enclosures. More often, there are mixed species, numerous body types, several foraging strategies and behaviors, and equally diverse food preferences. For example, animals that forage on the bottom may not have access to food broadcast on the surface. If special provision is not made to get food down to the bottom of these systems, less aggressive bottom-feeders may remain underconditioned (e.g. aggressive golden trevally, *Gnathanodon speciosus*, vs less aggressive benthic rays), or more aggressive top-feeding fish may outcompete less aggressive feeders in the same position of the water column (e.g. striped bass, *Morone saxatilis*, vs. bluegills, *Lepomis macrochirus*). Feeding the same amount of food to two voracious predatory fish (black sea bass, *Centropristis striata*, and crevalle jacks, *Caranx hippos*) may lead to two very different results, based on natural history traits (a more sedentary bass gains condition while a pelagic crevalle may lose condition). It may be useful to exploit different feeding schedules or methods to insure all animals in the system consume the diet most appropriate for them.

For bottom feeders in systems 5m or deeper (where feeding on tongs may be impractical), food can be delivered to the bottom directly via a pvc tube / venturi system. Food items also may be placed directly on the bottom by a diver in the system. For systems not as deep, tong feeding may be a viable option for feeding individual fish. For larger groups of fish, timed feeding may allow more aggressively feeding fish to be drawn to specific feeding locations, allowing less aggressive fish to be offered food with minimal competition. As with many other issues surrounding mixed species exhibits, most solutions demand creativity.

Live Food Items

Inclusion of live food items in aquarium diets provides another viable diet choice when maintaining collections (in some cases the only items a particular animal or species will consume). When live foods are used, it is imperative that biosecurity measures are in place to ensure these items are free of parasites and diseases, and avoid contamination of collection animals and aquarium systems. The measures include, but are not limited to: a predetermined

quarantine period, surveys of representative individuals, etc. The number of vendors supplying these items has been increasing with demand, but biosecurity measures and handling methods are inconsistent (i.e. cultured organisms, wild-caught organisms, or anything in between). Rather than relying on independent vendors to raise clean, live food, it may be more feasible to establish these cultures within the aquarium. The initial infrastructure and labor investment may be significant, as well as the long term maintenance of such systems, but this may be offset by the cost and uncertainty of acquiring live foods from a vendor. Items routinely maintained in culture by aquariums include: brine shrimp (*Artemia spp*), jellies, daphnia, rotifers, and an increasing amount of zooplankton (copepods, etc).

Nutritionally Complete Food Items

Given the ever-present issue of uncertain feeder fish population sustainability,^{1,6} the use of manufactured nutritionally complete feeds may allow those populations to be spared by using products that are more easily acquired, stored, and handled. Whether in the form of pellets, flakes, or gels, nutritionally complete items are becoming increasingly important for aquarium collection feeding. Unfortunately, what constitutes “nutritionally complete” for many aquarium species remains unknown. An increasing number of products have been developed to meet the needs of larger aquarium populations in size and form (pellets of various diameters and gels). It is important that the same effort be placed into formulating these products as true “nutritionally complete” food items designed specifically for target animals in order to act as true substitutes for more traditional whole fish and other seafood items.

Water Quality

The most common water quality problems in recirculating systems are ammonia or nitrite toxicity caused by imbalances between the filtration system and the bioload (fish stocking and feeding rates).⁹ The biomass of fish introduced to an exhibit can be controlled as stocking occurs, but once animals are present, they will often drive the amount of food offered. Overloading or overfeeding systems contribute greatly to poor water quality. As unconsumed food begins to decompose, the amount of fixed organic acid and carbon dioxide increases in the system. In marine systems, this consumes alkalinity, resulting in decreased pH. Even items that are consumed right away can influence water quality. Food that contains fat creates an oil film when it strikes the water surface. The item may be consumed right away, but the film remains. The film is pulled into the filters, reduced to small droplets (emulsified), and reintroduced into the system as haze. Leftover food also provides bacteria with an additional food source, which can contribute to decreased pH and dissolved oxygen within the system. There is a fine line between adequately feeding and overfeeding a system, and often water quality parameters are helpful indicators of the current feeding regime’s proximity to that threshold.

Lack of Guidelines or Target Nutrient Values

Most of the nutrient requirements for fish are based on aquaculture systems for intensively cultured species such as catfish, tilapia, striped bass, and various salmonid species.⁷ Perhaps more relevant for aquarium species are the advances made in semi-intensive finfish culture and the contributions to scientific literature from dedicated hobbyists and aquatic biologists that have

experienced the development of aquatic systems and fish keeping over the past two decades.⁵ There remains a notable paucity of data regarding the nutrient requirements of many species maintained in aquarium settings (seahorses, garden eels, moon jellies, etc). As aquaculture expands to include a wider variety of species, some of these informational gaps may be filled. In the meantime, clinical observations from public aquariums capable of housing single species in controlled systems may provide the best information for nutrient guidelines.

Overfeeding in Aquatic Systems

Most often, clinical observations of nutrient deficiencies or toxicities are the first sign of a problem, and nutritional diseases are often diagnosed as a result of excluding numerous other possible causes. In many cases, adjusting the dietary level of the most likely culprit will resolve the issue, and provide valuable information for diet formulation for the species in question. One of the most powerful tools to assess nutritional disorders in fish remains necropsy. It is a critical part of assessing the efficacy of a diet to maintain health of an animal. Overfeeding a system not only impacts the ability of the filtration system to maintain water quality, it also impacts the physical condition of the animals. Although anecdotal, hepatic lipidosis is a frequently reported post-mortem diagnosis in aquarium fish (A. Dove, personal communication), caused by overfeeding and overconsumption. Ensuring adequate access to food while not allowing overconsumption is a challenging task, and one of the greater challenges that faces aquariums with large, diverse systems.

Often, closely monitoring active feeding within a system will allow detection of overfeeding (food items will remain in the water column or on the bottom at the end of an active feeding period). Care should be taken, however to not overlook less aggressive feeders that wait until this period of reduced activity to initiate feeding. If specific target feeding is employed, individual diet reductions can occur for over-conditioned individuals. Again, creativity in managing how food is offered is imperative.

Food Handling, Preparation, and Quality Control

In many aquariums, food fish that are handled for marine mammals often receive the highest level of quality control. Items in marine mammal diets are inspected at various stages during the preparation process, beginning with pre-purchase evaluation and continuing until the item is fed to the target animal. Items used are restaurant grade, and often extensive nutrient profiles are available. Rarely do items in fish and invertebrate diets receive such scrutiny, however their quality is equally important and guidelines for handling food offered to aquarium fish are suggested to be similar to those established for marine mammals.³ A greater concern is the lack of nutrient content information available for many of the manufactured foods available to feed fish. It has been noted that guaranteed analyses provided by manufacturers and vendors of zoo animal diets do not always accurately describe the nutrient content.^{4,8} It is imperative that the nutrient content of each ingredient used in aquarium diets be accurately determined, and regularly checked for consistency.² Although aquarium professionals have successfully maintained a wide array of animals for centuries on diets that “just work,” there is little reliable information describing the nutrient content of those diets. Such information will become

increasingly important over time, as increasing numbers of delicate species are maintained in aquarium systems and natural food choices become more limited.

Conclusion

Preparation of adequate aquarium diets demands attention to a wide range of considerations. The relationships among these considerations are complex. Providing sufficient diet so that all animals in a system consume foods with an appropriate nutrient profile, while ensuring adequate body condition of those individuals and maintaining appropriate water quality, remains one of the greatest challenges facing nutrition of aquarium fish.

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