2012

Trends in the Marine Aquarium Trade: the Influence of Global Economics and Technology

Andrew L. Rhyne
Roger Williams University, arhyne@rwu.edu

Michael F. Tlusty
New England Aquarium, Prescott Marine Laboratory, USA

Recommended Citation

Rhyne, A.L. and M. Tlusty. 2012. "Trends in the Marine Aquarium Trade: The Influence of Global Economics and Technology." *Aquaculture, Aquariums, Conservation & Legislation* 5: 99-102.

Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

OPEN ACCESS
Communication

Trends in the marine aquarium trade: the influence of global economics and technology

[1,2]Andrew L. Rhyne, [1]Michael F. Tlusty

[1]New England Aquarium, Prescott Marine Laboratory, Boston, Massachusetts, United States of America; [2]Roger Williams University, Department of Biology and Marine Biology, Bristol, Rhode Island, United States of America.

Abstract. The marine aquarium hobby is a global industry with trade chains on six continents. This industry is undergoing rapid changes in hobbyist preferences that are in part driven by global economies and technology. In an effort to better assess the past trends and help provide insight into future growth and demand, we assessed three different trade data sources, the United States-State of Florida Marine Life Landings, CITES stony coral imports, and United States Fish and Wildlife Service's Law Enforcement Information Systems import data for 'live rock'. Data for the past 10 years were analyzed and a clear trend of growth followed by decline was observed with the peak and degree of decline varying for the different trade categories. While the global economic downturn decreased trade volumes across the board other forces have dramatically affected the importation of coral reef products. 'Live Rock' and Florida produced 'live sand' dramatically decreased two years prior to the global economic recession. The decline of these trade categories coincides with rapid changes in technology used to maintain captive reef aquariums which allowed for the advent of the smaller "nano" reef tanks. Importing and exporting countries, CITES and other international government bodies, concerned Non-Governmental Organizations and scientist would greatly benefit from a deeper understanding of this industry from a producer and consumer standpoint in order to better predict how the marine aquarium hobby will be shaped by external forces in the future.

Key Words: reef aquarium, coral trade, policy, import regulations, LED lighting, nano-reef.

Corresponding Author: A. L. Rhyne, arhyne@rwu.edu

Introduction

The marine aquarium hobby has seen rapid changes over the past 50 years (see Bruckner 2000; Wood 2001; Wabnitz *et al* 2003; Carpenter *et al* 2008; Rhyne *et al* 2009; Murray *et al* 2012). Changes in technology and economic livelihoods have affected the ability of consumers to procure and maintain marine aquarium species in captivity. For example, the routes of major international airlines control the ability to move live fish shipments from remote island atolls to the U.S. markets (Kinch & Teitelbaum 2010; Teitelbaum *et al* 2010). It can be said that the advent of modern aviation transport methods made the trade in coral reef species a global industry. Furthermore, rapid changes in husbandry technologies have allowed for marine aquarist to move from fish only tanks to aquariums that replicate living ecosystems (reef aquariums). Recently, these tanks were miniaturized to mini-reefs. These advances have been observed in the hobbyist literature, trade shows and online discussion boards (Riddle 2008; Adams 2010; Joshi 2010).

The rapid increase in the volume of coral reef species entering markets into the US, and EU has been the cause of great concern for governments, scientists and conservation community. Early in 2000's the United States Coral Reef Task Force and UNEP-WCMC took up the international trade of corals as a key issue of concern (www.coralreef.gov/international). The result was a several landmark publications about the trade (Bruckner 2000; Wood 2001; Wabnitz *et al* 2003). Recently the trade in coral reef species has come under the scrutiny from scientists (Smith *et al* 2008; Smith *et al* 2009; Tissot *et al* 2010) and in the United States, there has already been one legislative call for a ban on the importation of non-native species (H.R. 669) (Smith *et al* 2009). This action was proposed based on the assumed rapid increase in trade volumes that have occurred over the past few decades, lack of regulations in exporting countries and importing counties alike, and an overall lack of understanding of the trade data. Because the understanding of this trade data is poor, anticipated future demands based on how new technology or the global economic situations cannot be accurately forecasted.

The aquarium hobby has been termed a luxury hobby, and therefore it can be inferred that the economic health of the consumer will directly affect the size of the hobby. The U.S. is the major destination port for coral reef wildlife, and economic health was greatly affected by the global recession of 2007-2009 (Bricker *et al* 2011). Thus it would be expected that a corresponding down turn in reported landings and imports of marine aquarium species would be observed at the point of the global crisis. If so, these declines should be observed across the board, from fish, invertebrates, corals and live rock and should match the downturn in the global economy.

Table 1. Statistical values for the commodity groups presented in Figure 2. The coefficient of variation (c.v.) = s/m*100, and larger values indicated greater variability. Positive kurtosis values indicate a peaked distribution, where positive skewness indicates a larger positive (right) tail of the distribution. The percent ratio of the minimum to the maximum value indicates how small the lowest point of the trade was compared to the peak

	Fish	Inverts - SD	Plants	Live Rock	Sand	Sand Dollars	Corals
c.v.	23.54	28.24	37.06	53.45	54.3	26.22	28.39
Kurtosis	1.6	-1.16	-1.14	0.19	-0.9	-0.64	-0.66
Skew	0.78	-0.64	0.31	1.08	-0.12	0.04	0.4
Min/Max	41.19	41.49	31.5	23.73	9.59	39.03	40.52

The second major factor affecting the aquarium industry is technology. Technological advances are well documented in the hobby magazines as reviewed by leading hobby experts in the topic of lighting (Riddle 2008; Joshi 2010) and filtration (Adams 2010) as well as the public aquarium community or professional hobbyists (Leewis & Janse 2008). Perhaps the most significant change in husbandry technology that affects the size and accessibility of coral reef tanks is lighting. Changes in aquarium lighting have allowed for an increase in the number of manufactures offering packaged mini or nano-reef aquarium system (Figure 1) that are directly marketed to consumers for reef aquariums. Advances in technology will affect various species differentially and therefore, if technology drives trade trends, then the different categories of traded animals should not be synchronous as expected if trade was dominated by a single causative agent (such as the global economy). Here, these two hypotheses were examined using data for imports of stony and live corals, as well as domestic fishery production from the state of Florida (invertebrates, live corals, marine fish, plants, sand dollars, and sand).

Figure 1. A nano-reef aquarium. Used with permission. Photographer, Jake Adams, retains copyright.

Materials and Methods

In order to elucidate both the effects of the global economic recession and advances in husbandry technology have had on the aquarium trade we compared the landings and import data from four major sources. 1) stony corals imports into the United States from 2000 until 2009 from the CITES database, 2) landings reports by fisherman from the Florida marine aquarium fishery from 2000 until 2011 (fish, plants, invertebrates (minus sand dollars), sand dollars (representing the curio trade), and sand), 3) import data for "live rock" reported by importers to USFWS on wildlife declaration forms mandated by law and held in Law Enforcement Information Management Service database (LEMIS) from 2000-2011, 4) import data of all live "corals" reported by importers on wildlife declaration forms mandated by law and held in USFWS LEMIS from 2000-2011. This limited our data sources to that of import data reported by the United States Government and those reported to the State of Florida. These are most likely to reflect trends in the actual number of individual animals imported or landed in the fishery. These data are utilized with the caveat that they each have inherent strengths and weaknesses. We acknowledge known issues with data reporting in the CITES database (Phelps *et al* 2010; Rhyne *et al* In Press), and likewise with the LEMIS database (Smith *et al* 2008; Rhyne *et al* 2012). While alternate databases are being developed (Rhyne *et al* 2012) for now data analyses will focus on the extant LEMIS and CITES databases.

To determine trends in these datasets we plotted the total number of landings or imports over time from 2000 until the most recent completed year. Landing trends were compared to each other from 2000 until 2007 (the beginning of the global recession), and from 2007 until the most recent full year of data. The slopes from these two periods were compared to each other and general trends were observed. Distributional statistics (coefficient of variation, skewness, kurtosis, and the ratio of the minimum to the maximum) on yearly import volumes were also calculated for each trade category to assess trends in trade volume.

Results and Discussion

Trade data

Assessing the yearly trends in the volume of animals entering the marine ornamental aquarium trade, each of the commodity groups increases in popularity, reaches a peak, and then declines. The peak year varied from 2002 in Florida marine fish to 2008 in the live invertebrates from Florida. Live rock and sand had the highest coefficient of variation indicating the highest variability off the mean (Table 1). Live rock and fish had the most

peaked distributions (Table 1), and the positive skew indicated a larger tail above the mean (greater positive variation above the mean than below it).

As a whole, these variable trends across commodity groups indicate that multiple factors affect the trade in coral reef organisms. The global economic crisis did greatly affect this trade as a number of local peaks occurred in 2008-2009 (Figure 2). However, the 2003 peak in the live rock trade, and then its precipitous decline to 23% of its peak value, along with a 91% reduction in the sand trade, indicate a non-economic driver that significantly affected these items (Figure 2). As indicated in the introduction, technological advances, primarily in lighting will result in the declines for live rock and sand.

Advances in lighting the advance the husbandry of corals Reef aquarium lighting was primary based on two main technologies, the Metal Halide or High Intensity Discharge (HID) and Very High Output Fluorescents (VHO) until the late 1990s when the Compact Fluorescents Lamps (CPL) gained market share. These three types of lighting have dominated the trade from the advent of coral husbandry until recent. The general trend in increasing specialization of lamp spectral output is well

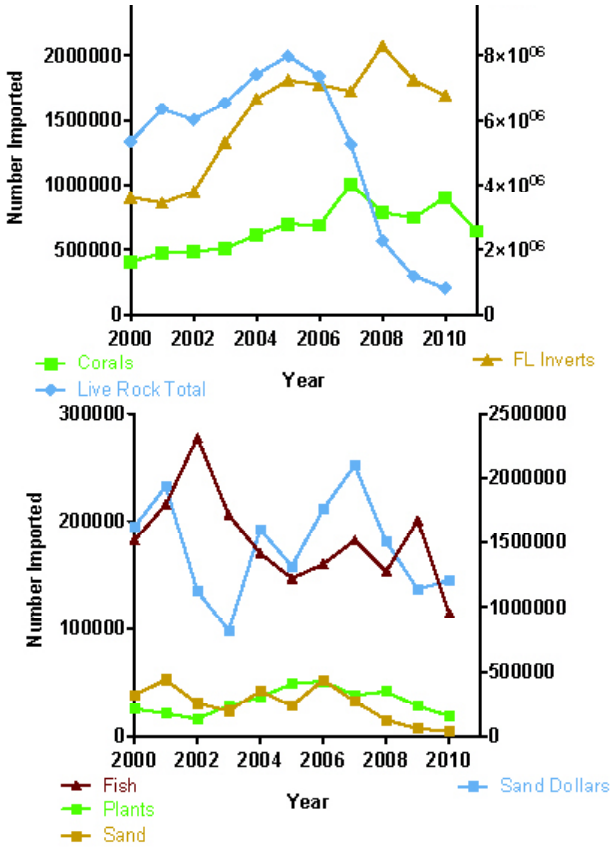

Figure 2. Trends in the marine aquarium hobby as depicted by 10 years of import data. Top, is 10 years of import data for corals and live rock imported into the United States and marine invertebrate landings from the State of Florida, United States. Bottom, is 10 years of landing data from Florida for marine fish, 'plants', live sand, and sand dollars (curio). The legend is below the y-axis on which the data are graphed.

reviewed in the hobby literature and forums (Adams 2010). While each of these lamps has been demonstrated to grow and sustain corals, they have the disadvantage of requiring large amounts of energy, along with producing heat and inferred light creating a significant heat load. This is particularly of concern for smaller aquariums, as smaller volumes of water have less thermal elasticity. Hobbyists can counter this by equipping their aquariums with heat exchangers to draw excess heat from aquarium water. Additionally, the size of the HID and VHO lights limits the minimal size of the aquarium. The advent of the CPL lighting allowed for spectral specialization and thus hobbyists could create reef environments in small aquariums, termed mini or nano reefs. Nano and mini reef aquariums are under 100L in size and have been featured in the hobbyist literature as small as 25L (Adams 2010). While CPL lighting allowed for a smaller more compact aquarium without the heat concerns of HID lighting, this now pales in terms of advances occurring in technologies surrounding Light Emitting Diodes (LED) (Joshi 2010). Aquariums could now be lit with energy efficient LED lights that produce very little direct thermal heat and indirect IR heat into the aquariums allowing for sustained coral growth at rates similar to those of HID lighting. This has effectively removed the limitation of heat dissipation on aquarium size and at the same time reduced the operating costs for aquarist.

Conclusions

Moving trade monitoring forward

The trade in coral reef organisms is complex and is affected by technology and global economic health. Here, we report on a correlation between the advent of small home reef aquaria ('nano' tanks), and a decline in the harvest of biological active coral rock and sand. While suggestive, in a pure sense, correlation does not imply causation. There are other factors that may influence the trade in corals. As an example, the quality of coral products may affect import levels. Unfortunately these data are not collected, but the rapid appearance in the trade and proportional increase of corals originating from Australia (Rhyne *et al* In Press), and the general impression these are of "high quality" may indicate market sensitivity to animal vigor. In addition, the global coral market is also affected by the increase in coral aquaculture. As discussed in Rhyne *et al* (In Press), aquaculture production of corals (Parks *et al* 2008) will result in a decrease in the trade statistics of wild coral imports. More importantly, when the aquaculture production of corals is domestic, it will affect trade statistics by decreasing import volumes. However, without a suitable means of tracking domestic aquaculture coral production, the trade statistics will merely show a decline in volume, and not a shift in source country production.

The future of the coral (Rhyne *et al* In Press) and marine tropical fish trade (Rhyne *et al* 2012) are rapidly evolving. Difficulties in monotypic data recording, type instead of species declarations and "hidden" domestic production (Rhyne *et al* 2012) will complicate a full understanding of this trade. Future management adjustments need to fully address species and type variation and the vagaries in listing to this level of data, as well as prompt recording of trade emanating from all source countries. These improvements are necessary to allow for a full valuation of this biodiverse global trade.

Acknowledgements

Florida landing data was provided by Florida Fish and Wildlife Commission as part of the Federal Trip Ticket Program. United States Fish and Wildlife Services kindly provided the import data for 'Live Rock'. Rhyne is supported by A National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program Grant NA09NMF4000385 and is thankful to the Ocean Foundation and the United States Department of Commerce National Oceanic and Atmosphere Administration, Office of Habitat Conservation for the invitation to present at the 2011 stony coral mariculture workshop, Bali Indonesia, the origin of this research. Jake Adams kindly provided the use of the nano -reef aquarium in Figure 1.

References

Adams, J., 2010. Reefing like it's 1999: How reef aquarium flow and lighting has changed over the past decade. Advanced Aquarist Online Magazine IX:www.advancedaquarist.com/2010/2011/review2012.

Bricker, J., Bucks, B., Kennickell, A., Mach, T., & Moore, K., 2011. Surveying the aftermath of the storm: Changes in family finances from 2007 to 2009 Federal Reserve Board, Finance and Economics Discussion Series: Working Paper 2011-17, March 2011.

Bruckner, A., 2000. New threat to coral reefs: Trade in coral organisms. Issues in Science and Technology Fall 2000:1–6.

Carpenter, K. E., Abrar, M., Aeby, G., Aronson, R. B., Banks, S., Bruckner, A., *et al*., 2008. One-third of reef-building corals face elevated extinction risk from climate change and local impacts. Science 321(5888):560-563.

Joshi, S., 2010. Quantitative comparison of lighting technologies: Metal halide, t5 fluorescent and led. Advanced Aquarist Online Magazine IX:www.advancedaquarist.com/2010/2012/aafeature2012.

Kinch, J., Teitelbaum, A., 2010. Proceedings of the sub-regional workshop on the marine ornamental trade in the pacific. Noumea, New Caledonia: SPC Aquaculture Technical Papers / Secretariat of the Pacific Community. 69 pp.

Leewis, R. J., Janse, M. (Eds), 2008. Advances in coral husbandry in public aquariums (Vol. 2). 438 pp.

Murray, J. M., Watson, G. J., Giangrande, A., Licciano, M., Bentley, M. G., 2012. Managing the marine aquarium trade: Revealing the data gaps using ornamental polychaetes. PloS One 7(1):e29543.

Parks, J. E., Pomeroy, R. S., Balboa, C. M., 2008. The economics of live rock and live coral aquaculture Marine ornamental species. Blackwell Publishing Company, pp.183-206.

Phelps, J., Webb, E. L., Bickford, D., Nijman, V., Sodhi, N. S., 2010. Boosting cites. Science 330:1752-1753.

Rhyne, A. L., Rotjan, R., Bruckner, A., & Tlusty, M. F., 2009. Crawling to collapse: Ecologically unsound ornamental invertebrate fisheries. PloS One 4(12):e8413.

Rhyne, A. L., Tlusty, M. F., Kaufman, L., In Press. Long-term trends of coral imports into the united states indicate future opportunities for ecosystem and societal benefits. Conservation Letters.

Rhyne, A. L., Tlusty, M. F., Schofield, P. J., Kaufman, L. E. S., Morris, J. S., Bruckner, A., 2012. Revealing the appetite of the marine aquarium fish trade: The volume and biodiveristy of fish imported into the united states. PloS One DOI:10.1371/journal.pone.0035808.

Riddle, D., 2008. Product review: Lighting for reef aquaria: Tips on taking light measurements. Advanced Aquarist Online Magazine VII:www.advancedaquarist.com/2008/2002/review.

Smith, K. F., Behrens, M., Schloegel, L. M., Marano, N., Burgiel, S., Daszak, P., 2009. Reducing the risks of the wildlife trade. Science 324:594-595.

Smith, K. F., Behrens, M. D., Max, L. M., Daszak, P., 2008. U.S. Drowning in unidentified fishes: Scope, implications, and regulation of live fish import. Conservation Letters 1:103-109.

Teitelbaum, A., Yeeting, B., Kinch, J., Ponia, B., 2010. Aquarium trade in the pacific. SPC Live Reef Fish Information Bulletin 19:3-6.

Tissot, B. N., Best, B. A., Borneman, E. H., Bruckner, A. W., Cooper, C. H., D'Agnes, H., *et al*., 2010. How U.S. Ocean policy and market power can reform the coral reef wildlife trade. Marine Policy 34:1385-1388.

Wabnitz, C., Taylor, M., Green, E., Razak, T., 2003. From ocean to aquarium. Cambridge, UK: UNEP-WCMC. 64 pp.

Wood, E. M., 2001. Collection of coral reef fish for aquaria: Global trade, conservation issues and management strategies. UK: Marine Conservation Society.

Authors

•Andrew L. Rhyne, Roger Williams University, Department of Biology and Marine Biology, One Old Ferry Road, Bristol, RI 02809 USA. (p) 401-254-5750; (f) 401-254-3310; e-mail: arhyne@rwu.edu

•Andrew L. Rhyne, John H. Prescott Marine Laboratory, New England Aquarium, Central Wharf, Boston MA 02110; e-mail: arhyne@rwu.edu

•Michael F. Tlusty, John H. Prescott Marine Laboratory, New England Aquarium, Central Wharf, Boston MA 02110. +1-617-973-6715; e-mail: mtlusty@neaq.org

Citation	Rhyne, A. L., Tlusty, M. F., 2012. Trends in the marine aquarium trade: the influence of global economics and technology. Aquaculture, Aquarium, Conservation & Legislation 5(2):99-102.
Editor	I. Valentin Petrescu-Mag
Received	19 March 2012
Accepted	31 May 2012
Published Online	30 June 2012
Funding	Rhyne is supported by A National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program Grant NA09NMF4000385
Conflicts/ Competing Interests	None reported