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Head-starting Turtles: Learning from Experience

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The papers in this volume are the result of the symposium "Head-starting Turtles—Learning from Experience" held at the 2010 Joint Meetings of Ichthyologists and Herpetologists in Providence, Rhode Island, USA. The symposium was co-chaired by Rick Hudson, Thomas Leuteritz, and me. Our symposium was not intended as advocacy for or against head-starting, but instead as an acknowledgement that head-starting turtles is occurring and that there is much to learn from these ongoing activities. We heard 28 papers on head-starting for a wide variety of turtle species from all over the world. Many more scientists and conservationists wanted to present but could not attend.

Head-starting is carried out as part of many turtle conservation projects (e.g., TCF 2002). Perhaps the most clear-cut evidence that head-starting is accepted as a necessary component of turtle conservation projects is that perhaps the world's most prominent turtle conservation organization, the Turtle Survival Alliance, is currently involved in head-starting at least 11 species: *Astrochelys yniphora**, *Batagur baska**, *B. affinis*, *B. borneoensis*, *B. kachuga*, *B. trivittata**, *Chitra indica*, *C. chitra**, *Geochelone platynota**, *Macrochelys temminckii**, *Podocnemis lewyana*; (*indicates captive hatched turtles; Rick Hudson, pers. comm.). Other conservationists are head-starting still more species, such as *Batagur borneoensis* and *Mauremys annamensis* (Peter Paul van Dijk, pers. comm.; see TCF 2002). We should all expect a flow of new information as these conservationists release and track more turtles, and publish their results.

There is, however, apparently no well-recognized and accepted definition of head-starting itself, at least in the sense meant in these collected works. The IUCN-SSC (2013) stated that head-starting reptiles "avoids the heavy mortality of young age classes in the wild; wild hatchlings are reared in protective enclosures before release at less susceptible size/age." Here, I define it as the practice of protecting especially vulnerable life stages of a species to increase the likelihood of survivorship for conservation purposes. Head-starting wildlife is probably as old as wildlife conservation and management itself because helping individuals survive especially vulnerable life stages often seems an obvious and appealing way to increase population persistence. Head-starting also has a long history in wildlife rescue and rehabilitation, where it focuses specifically on individuals. Therefore conservation and rescue workers have developed a diverse array of relevant husbandry techniques (e.g., Murphy et al. 1994; Moore and Joosten 2002; Gage and Duerr 2007; AZA 2011, and many articles in journals such as Zoo Biology) applicable to head-starting practitioners. Some projects that involve the introduction of captive-raised turtles (e.g., Griffiths et al. 2010, 2012; Hunter et al. 2013a, b) into places where that species did not previously occur could be considered head-starting, even if the conservation goals involve ecosystem restoration rather than turtle conservation. Certainly these projects can be instructive examples for more typical head-starting programs.

Similarly, there is no generally accepted definition of head-starting success, at least in part because the goals of different head-starting projects are probably different. Pritchard (1981) suggested evidence that "head-started turtles have a greater chance of becoming part of a breeding population than do hatchlings that were not head-started" could provide support for head-starting as a valuable activity, but more is needed to demonstrate its cost-efficiency for population restoration. Short-term goals providing evidence that head-started turtles survive to be caught later, that they are healthy, and that they have grown as appropriate for their age should be considered because of the difficulty of collecting long-term data assessing recruitment of head-started turtles into breeding populations (Pritchard 1981). Eckert et al. (1994) similarly defined as short term goals evidence that head-started turtles were competent during and after release, grow and survive in the wild, and are recovered in a reasonable proportion to non-head-started turtles. Eckert et al. (1994) defined as long-term success evidence that the proportion of nesting head-started turtles grew relative to non-head-started turtles, and evidence of adult survival rates at or above those of non-head-started turtles. Our hope for the symposium was a collection of papers that would address some of these goals, and thus we are proud of the papers that follow. I hope the people who were not able to participate in our conference will augment the work presented here.

While conservationists had used head-starting for a very wide range of animal and plant species, turtle head-starting is special for a variety of reasons. All turtles are oviparous, few species provide any post-oviposition parental care, and their eggs and hatchling stages are usually their most vulnerable stages. Therefore, turtle head-starting involves protecting eggs and young, and unlike mammals and birds, no surrogates for parental care and training are needed. Also unlike most animals, there are at least four options available to head-start turtles, mostly because nests in many turtle species are not too difficult to find and protect in the field. First, practitioners can protect turtle nests they find in the field with predator-excluders. This provides for the eggs to remain in situ; with excluders constructed to allow hatchings to escape upon emergence (e.g., Ratnaswamy et al. 1997). Second, we can protect nests with predator-excluders that do not allow hatchlings to escape. Instead hatchlings are collected and raised in captivity until they reach the desired age or size for release (Russell Burke, unpubl. data). Third, practitioners can move nests to safer locations in the field. Most commonly, these nests are moved as a group to facilitate protection and monitoring (Pritchard 1980). Fourth, eggs are collected and then incubated in captivity. The resulting hatchlings are either released immediately after hatching or after a period of husbandry. Egg collection typically involves either removal from nests, hormonal inducement of oviposition after capture of gravid females (e.g., Spinks et al. 2003), or recovery from road-killed females (e.g., Herlands et al. 2004). The high frequency with which eggs are available as a result of female road mortality is probably unique to turtles. Another technique fitting under the broad definition of head-starting is the use of protected areas where turtles can lay naturally with low risk of nest predation (e.g., Bennett et al. 2009; Smith et al 2013).

Two unusual and fortunate aspects of turtle head-starting are that most turtles are relatively easy to raise from eggs to juveniles even in large numbers, and hatchlings have tremendous public appeal. For example, facilities that house large numbers of sea turtle or Galápagos Tortoise hatchlings are popular tourist sites, providing significant opportunities to generate income. Nothing comparable exists for snakes, lizards, or any amphibians.

There are numerous papers critical of head-starting; I only summarize these papers and their main points. At least three important criticisms have been raised concerning the efficacy of turtle head-starting. First, adult turtles in natural conditions generally have high natural annual survivorship coupled with generally low egg and hatchling survivorship. These life histories therefore depend on adult females having multiple reproductive opportunities over exceptionally long life spans. Population models (e.g., Congdon et al. 1993; Heppell 1998a, b; Heppell and Crowder 1998) clearly show that turtle population persistence is much more sensitive to survivorship of subadults and adults than survivorship of younger life stages. Given that conservation resources are always limited and resources spent on head-starting means fewer resources for other conservation needs, it is much more valuable to protect subadults and adults than to head-start eggs and hatchlings (Heppell 1998; Heppell and Crowder 1998). Turtle populations can persist for many years with little recruitment, but are quickly extirpated if adult survivorship is also low.

A second important criticism is that head-starting can be a “halfway technology” in that it does not necessarily address the most important conservation issues for turtles (usually adult survivorship), and therefore can be either useless or a detrimental distraction from effective conservation actions (e.g., Woody 1991; Frazer 1992; Klemens 2000; Seigel and Dodd 2000). For example, releasing head-started hatchlings into an environment where appropriate habitat for survival is not available will not address conservation concerns. This point was made especially poignant when it became clear that years of incubation for the Kemps Ridley head-starting program had probably produced mostly male hatchlings, because the phenomenon of temperature sex determination was not known at the time (Wibbels et al. 1989). Finally, turtle head-starting programs may fail if head-started hatchlings do not behave appropriately or are diseased (e.g., Bowen et al 1994; Klemens 2000; Seigel and Dodd 2000). Head-starting programs can be expensive, and it is possible that survivorship of resulting neonates is too low to justify the effort (Dodd and Seidel 1991; but see Burke 1991).

These criticisms have been addressed previously (e.g., Allen 1990; Mortimer 1995) and by the papers in this volume. Certainly, adult turtles play a more important role in the persistence of turtle populations than do eggs or hatchlings, but optimal conservation choices are often complicated by political and social factors. Eggs and hatchlings are relatively inexpensive to protect and raise, and a small investment can have a large impact (Alho 1985). Most conservation measures to assist adults are expensive and complicated, and cost-benefit analyses could prove very useful (Alho 1985; Galbraith et al. 1997). More importantly, the public finds turtle hatchlings attractive, and they make excellent ambassadors to the general public by generating interest in all levels of conservation. Hatchling sea turtles are easy to see close-up, they are cute, and even school children can participate in their conservation in a hands-on way. For example, some head-starting programs have school children participate in hatchling releases (e.g., Fontaine et al. 1989; Herlands et al. 2004; Maciantowicz and Najbar 2004).

Numerous turtle head-starting programs already parley these characteristics of turtle head-starting programs into raising awareness and funds for conservation of adults. One example of the value of head-starting for adult conservation is the result of the long term collaboration between Richard Stockton College and the Wetlands Institute in New Jersey (Wood and Herlands 1997; Herlands et al. 2004). This program was developed to recover viable eggs from road-killed Diamond-back Terrapins (*Malaclemys terrapin*) on a road through the area. Eggs are incubated and hatchlings raised for approximately nine months. The releases are heavily publicized and school children are allowed to participate. The resulting media attention has led to recruitment of many volunteers who assist in reducing road mortality, both through fencing and signs to alert drivers. The use of the hatchlings to attract the attention of school children led to the involvement of their parents who helped protect the adult turtles (Roger Wood, pers. comm.). In my own research, I have found that citizen scientists who help me in the field tend to view their work censusing adult Diamond-back Terrapins as being far more valuable if at the same time they are able to protect nests. Conservationists do not need to think only about whether resources committed to head-starting would be better spent on adults; efforts in both directions can be compatible. In contrast to Klemen's (2000) suggestion that strategies such as head-starting only makes sense if conservationists maintain a narrow focus, the reverse seems to be true.

The criticism that head-starting cannot succeed if the cause of the conservation issues are not addressed is obviously correct. That does not mean that head-starting cannot be useful, only that it cannot succeed in any meaningful sense if used as the only conservation strategy. If used, for example, to create and encourage interest in conserving adults as described above, head-starting can be much more than a half-way technology.

Finally, these proceedings were conceived in part to determine whether the claim that there is little or no evidence that head-starting works was based on a poor record of publishing results or the lack of positive results (but see Appendix 1 and Burke 1991; Townsend et al. 2005). The former possibility is certainly at least partially the case, because many head-starting programs are poorly funded and the people involved may have little incentive to report their work in peer-reviewed literature. Much of what has been published is in the gray literature. Head-starting programs for many species face the problem of poor monitoring, and that is exacerbated with turtle head-starting programs due to their long age to maturity. Part of the lack of evidence of success may be due to differing definitions of success (Burke 1991).

Information regarding unsuccessful results is rare, perhaps because people are probably much less likely to publicize unsuccessful conservation programs. So what we saw before we held the 2010 conference was a small number of papers reporting head-starting projects with some measure of success, and some news releases indicating that projects had been started, but with no follow-up. I list some of these and related papers (Appendix 1) but see the other papers in this issue for more examples, especially for sea turtles.

We wanted to add some papers with robust data to address the question: can head-starting be a useful tool in the conservationist's tool box? I think the following eleven papers help answer that question. However, there is no doubt that we need far more studies, with rigorous data collection and long term monitoring, to improve the quality of the answer.

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Editor's addendum.—There were a number of uncharacteristic difficulties that arose during this process, and I feel compelled to acknowledge these and sincerely thank Russell Burke and the symposium authors for their patience during manuscript processing. Sincerely, Malcolm L. McCallum, Managing Editor.

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APPENDIX

Table A1. List of published literature that report the results of turtle head-starting projects. 1 = recaptured, 2 = gravid, 3 = survived until at least 1988, 4 = lost weight, 5 = transitter failure, 6 = survived 2 years, 7 = survived 4 years, 8 = see Gerlach et al. 2003, 9 = survived 6 months post-release, 10 = still alive in 2008, 11 = recaptured after one year, 12 = recaptured in 1991.

Source	Common Name	Scientific Name	Release Date	Release Number	Status
Bell et al. 2005	Green Sea Turtle	*Chelonia mydas*	1980-2001	30,769	392[1]
Bona et al. 2012	European Pond Turtle	*Emys orbicularis*	1999	18	2[1,2] in 2000
Brewster and Brewster 1991	Wood Turtle	*Glyptemys insculpta*	1985	10	8[3]
Cantarelli 1997	Giant Sideneck River Turtle	*Podocnemis expansa*	1979-1991	17 million	Unknown
Cassim 2006	Spotted Turtle	*Clemmys guttata*	2004-2005	14	14[4 or 5]
Cayot et al. 1994; Cayot and Morillo 1997, Fritts et al. 1999	Espanola Galápagos Tortoise	*Chelonoidis hoodensis*	1975-1994	661	population re-established
Coyot et al. 1994; Fritts et al. 1999	Pinzon Galápagos Tortoise	*Chelonoidis duncanensis*	?	268	184[1]
Das 2011	Hawksbill Sea Turtle	*Eretmochelys imbricata*	?	2640	No Monitoring
Garrigues and Cadi 2011	African Spurred Tortoise	*Centrochelys sulcata*	2006	24	90%(?)[6], 80%[7]
Gerlach et al. 2013; Gerlach and Gerlach 2011a	Indian Ocean Island Giant Tortoises	*Aldabrachelys* (*Dipsochelys*) sp.			Data are complex[8]
Gerlach and Gerlach 2011b	Black Mud Turtle	*Pelusios subniger parietalis*	2002, 2003	5, 18	5[9], 6[10]
Haskell et al. 1996	Red-bellied Turtle	*Pseudemys rubriventris*	1985-1988	63	39[11], 27[12]
Herlands et al. 2004; Wood and Herlands 1997	Diamondback Terrapin	*Malaclemys terrapin*	1989-current	>3,500	some returns as adults
Kuchling 1997, 1999, 2008	Western Swamp Turtle	*Pseudemydura umbrina*	1994	?	?

Russell L. Burke received his B.S. in Zoology from Ohio State University, his M.S. in Wildlife Ecology from University of Florida, and his Ph.D. in Biology from University of Michigan. He has worked at Hofstra University in New York since 1996, and is now a Professor, Department Chair, and Donald E. Axinn Distinguished Professor in Ecology and Conservation. He has conducted phylogenetic, ecological and conservation research on a wide variety of turtles and lizards and has published 45 papers, primarily on Gopher Tortoises, Desert Banded Geckos, Painted Turtles, Diamondback Terrapins, Italian Wall Lizards, Eastern Long-necked Turtles, Hermann's Tortoises, Eastern Box Turtles, Eastern Fence Lizards, Coyotes, White-tailed Deer, Raccoons, and Kangaroo Rats. He's run a citizen science program involving research on Diamondback Terrapin in Jamaica Bay, New York since 1998 and has also conducted long term ecological projects on eastern box turtles and wood turtles. He has been an Associate Editor for Journal of Herpetology since 2007. He has supervised 13 completed M.S. students thus far. Along with Rick Hudson and Thomas Leuteritz, he co-chaired the symposium Head-starting Turtles—Learning from Experience at the 2010 Joint Meetings of Ichthyologists and Herpetologists in Providence, Rhode Island, USA, and edited the resulting papers from that symposium.