

Dr. Kevin Bonine

A. Biological Pollution; Human Introduced Threats to Sonoran Desert Ecology



B. Authors

Emily Kaleugher, Alex Lichtblau, Josh Ruddick

November 18, 2009

C. Summary

Biological pollutants that alter the ecology of the area or threaten specific species, are often introduced intentionally by humans to solve other issues. Focusing on three examples of human interventions that have adversely affected Sonoran Desert ecology we will examine two invasive species and one instance of human recovery efforts gone awry. Through this outreach workshop we hope to enlighten the public on issues such as the dispersal of non-indigenous species, and the harm caused by these organisms. Through education, we hope to instill a sense of urgency and importance to the public, but also relate the information to them in a way which shows the importance of such study to their own lives. Also we would like to demonstrate to the public the extent and range of research coming from the University of Arizona, and our commitment to bettering the natural world around us as well as the lives of the people affected by it. Our goal will be to raise awareness in relation to these specific species and emphasize the need to think carefully about the possible ecological impacts of human intervention before that intervention takes place.

D. Target Audience

The audience will be the general public. The activities and information will be presented so that children from six and up can benefit, but educated adults will also be engaged.

E. Introduction and Background

The desert, although harsh and unforgiving, is at the same time a fragile ecosystem. Slight perturbations of the natural composition of flora and fauna can lead to devastating breakdowns of ecosystem structure and function. Invasive species is a term used to describe such biotic newcomers, which are often introduced intentionally by humans to address other issues.

- **The Bullfrog, by Alex Lichtblau**

The American bullfrog *Rana catesbeiana*, has not only survived being introduced to the Sonoran Desert, but thrived after its introduction into the American southwest.



This hardy frog, the largest in the US, is a perfect invader thanks to some of its biological and morphological features (Rorabaugh, 2008). Some of these features include the following: the ability to reproduce very rapidly and in astounding numbers, the ability to travel large distances without standing water, the propensity to eat almost anything it can fit in its mouth, as well as their ability to withstand a

wide range of environmental conditions. It is for these reasons that the introduction of the bullfrog has such serious implications in the desert landscape.

The bullfrog, native to the eastern United States, was introduced to the southwest sometime between the late 19th century and early 20th century as a source of food. During the time of the introduction, it was believed that introducing this large, meaty frog could alleviate some of the stress on native fauna and supply people with a supplemental food source organism. In other parts of the western United States, the bullfrog was released unintentionally in the process of stocking streams, rivers and lakes with fish (Rorabaugh, 2008). Regardless of intention, the introduction caused many more problems than it has solved.



The impacts associated with the bullfrog are vast. The most evident and troubling issue is the predation and eradication of native species. As stated earlier bullfrogs are voracious predators and have been known to eat snakes, birds, small mammals and other frogs; herein lies the problem. As bullfrogs thrive, they indirectly affect native predators, such as snakes and other frogs, through competition and reduction of resources. As well they deplete native organisms' numbers directly through predation. Many native species like the lowland leopard frog *Rana yavapaiensis* and garter snakes of the genus *Thamnophis* suffer huge losses at the mouths of bullfrogs. This is in part due to their high mobility. Some frogs have been recorded as traveling almost 7 miles between water sources (Rorabaugh, 2008). This incredible ability makes them more of a threat because it is almost impossible to control their populations or even track their expansion. Worldwide, amphibians are diminishing at an alarming rate, and in many areas the bullfrog may be to blame (Ficetola et. al. 2007).

Due to their high mobility, voracious appetite, high fecundity (some clutches can be as large as 20,000 individuals, as opposed to the 2,000-3,000 laid by native species) and hardy demeanor *Rana catesbeiana* has the potential to ravage many ecosystems and study of this organism is highly important for generating management and control policies (Roach, 2004). Allowing the American bullfrog to continue to thrive and destroy native habitat and its fauna is no longer an option, and only if we understand the organism and its relationships to indigenous species can we effectively control the bullfrog.

The University of Arizona is one of the forerunners in invasive species research, and our very own Cecil R. Schwalbe is considered a leading expert in the field of reptiles and amphibians (Roach, 2004). Much of his work at the University of Arizona and the United States Geological Survey with the Southwest Biological Science Center has been focused on *Rana catesbeiana* and its rapid dispersal and profound influence on the ecology of the southwestern United States (USGS, 2009).

- **Buffelgrass, by Josh Ruddick**

Buffelgrass (*Pennisetum ciliare*) is native to Africa and was introduced to Arizona in the 1930's for erosion control and as a food grass for cattle. It is a perennial, aggressive grass that grows in very dense bunches. It has an extensive, deep root system and can reproduce through wind dispersed seeds or by means of rhizomes. Buffelgrass represents a multidimensional threat to Sonoran Desert Ecology. First, because it grows so densely, native seeds that fall in areas contaminated with Buffelgrass cannot hit the ground and germinate. Second, because it not only has a deep root system but also a system of rhizomes that run just under the surface of the soil, it can outcompete even the hardiest of desert cacti and shrubs for vital water and nutrients. A study completed in Australia indicated that buffelgrass



actually has a higher long-term impact on the abundance of native plants than annual rainfall. (Clark et al, 2005) Finally, it is a grass that is prone to catch fire (Brooks et al, 2004).

The native species of flora and fauna in the Sonoran Desert are not fire tolerant (Alford et al, 2005). They did not evolve in an ecosystem that was prone to fire. For example, cacti and native shrubs have developed the sprawling root systems in



order to capitalize on the summer monsoon rains (Nobel, 1997). Because the root systems of many native plants grow in this manner, the plants are separated spatially in such a way that fire does not travel from plant to plant. As a result, the

Sonoran Desert is essentially fire proof. In cases where Buffelgrass has invaded, it fills the space in between the native species and provides a dense fuel for fires to use and spread. Native species that are not adapted to fire add more fuel, creating intensely hot and fast moving fires that kill native cacti, including the iconic saguaro, and other plants.

Plants that are native to the desert also have very slow metabolic rates in order to cope with drought conditions. Because of the slow growth rate of native species of plants, it is very difficult for the native desert to recover from a fire (Norag and Wilson, 1994). The slow recovery of native species provides yet another opportunity for buffelgrass to assert itself before any other species can.

The University of Arizona in concert with Pima County, The National Park Service, The Bureau of Land Management and the City of Tucson is conducting research on the efficacy of airborne spraying of herbicides to control buffelgrass. The ongoing study began in August of 2008 with the goal of eradicating this pernicious invader from the Sonoran Desert without adversely effecting native plants and animals.

Buffelgrass may be the single most threatening invasive species to native desert ecology. If buffelgrass continues to crowd out native species the landscape will forever be changed and many of our unique plant and animal species will not survive. Should buffelgrass not be controlled it is likely it could crowd out all other native species (Fairfax and Fensham, 1999).and this region will begin to look and behave more like an African savannah rather than the uniquely beautiful and widely diverse Sonoran Desert

- **Released Captive Desert Tortoises, by Emily Kaleugher**

The desert tortoise (*Gopherus agassizii*) is a solitary, fully terrestrial creature turtle that inhabits the deserts of southwestern United States and parts of northern Mexico. Known for its distinctive hard shell and scaly forelegs, the desert tortoise is greatly protected against large predators (Desert Tortoise Management 2009) and can live a full century. Dependent on adequate shelter for thermoregulation, tortoises often build their burrows under large boulders and in the banks of arroyos to insulate themselves from the extreme temperatures of the desert (Averill-Murray 2000). Inside these burrows, tortoises will hibernate during freezing winter months and estivate during hot early summer periods (Averill-Murray 2000). Desert tortoises are herbivorous and are most active during spring and the wet summer monsoon months when green vegetation is plenty. The majority of water requirements are fulfilled by the tortoise's diet- consisting of native grasses, fresh perennials foliage, desert flowers and the occasional prickly pear fruit (Desert Tortoise Management 2009). However, tortoises will take advantage of puddles of water and re-hydrate themselves by drinking or absorbing water through their cloaca (Averill-Murray 2000). Although exact mating times can vary, sexually mature females ages 12-20 years will typically mate in April and lay one clutch of approximately 3-12 eggs inside their burrow from May-July (Averill-Murray 2000). During the monsoon months, male-male combat is common, as competition for females motivates activity.

Two main subspecies of desert tortoise exist- populations of which are physically separated by the Colorado River. These populations have evolved separately over many years, but look almost identical. The Sonoran population is found south and east of the river (in the Sonoran Desert), and the Mojave population is found north and west of the river (in the Mojave Desert) (Sonoran Herpetologist 2008).

In 1989, the Mojave population of desert tortoises was official listed as endangered under the Endangered Species Act (Howland 1994). Large die offs of the Mojave tortoises in California prompted research and action to be taken to find the cause of population losses (Howland 1994). In addition to habitat loss and fragmentation (due to roads and housing developments) researcher now believe that released and escaped captive tortoises into the wild are hurting wild tortoises (Sandmeier et al. 2009; Jones et al. 2005). Captive tortoises can negatively affect wild tortoise populations by introducing diseases, hybridizing the two subspecies, and out-competing/displacing local tortoises (Desert Tortoise Management 2009).

Upper respiratory tract disease (*Mycoplasma agassizii*) is a bacterium-caused infection that stays with the tortoise for its full life and can lead to their death. The disease is transmitted when infected tortoises come into direct contact with healthy tortoises. URTD causes cold like symptoms, including puffy,



runny eyes, runny nose, wheezing and bubbles coming from the nasal passages (Jones et al. 2005). Stress triggered by the introduction of roads, construction, off-road vehicles, domesticated dogs, and concentrated numbers of captive tortoises can cause flare ups in the symptoms. Some studies show that in the Mojave populations, adults were more likely to test positive to URTD exposure (Johnson et al. 2006). Due to the long lived nature of desert tortoises, recruitment would see a decline if adult tortoises died before female could reproduce.

Hybridization is threatening to wild populations of desert tortoises because mixing genes between two subspecies of tortoises that would never be able to naturally combine, damages the integrity of the species. Over time, whole populations in fragmented areas of the desert may become a new hybrid species, essentially making the previous species disappear completely. With travel across state lines common, many pet owners transport tortoises into new species' ranges. If the tortoise should ever be released or escape into the wild it could potentially mate with local populations. It can be difficult to distinguish between the Mojave and Sonoran subspecies (sometimes requiring genetic sampling) and it is not practical to assume pet owners are practicing responsible hybrid-free breeding. Therefore, any captive or captive-born juvenile tortoises can never be released into the wild.

Captive tortoises that end up in the wild may threaten local populations through displacement (Desert Tortoise Management 2009). Native tortoises have very specific home ranges and if a released tortoise takes the native's burrow and feeding area, then it is possible for the local tortoise to succumb to the elements and be replaced (Desert Tortoise Management 2009).

Whether captive born or re-introduced into the wild, pet desert tortoises can never be released into the wild. Well-intentioned people may find a tortoise in the wild and try to nurse it back to and release it back into the wild. Other people may get tired of their tortoises and release it, believing that their pet would have a happier life in nature. Still, others may start breeding tortoises because they think babies are cute and release them into the wild- thinking that they are doing a service to help increase tortoise numbers. Researchers are still trying to understand the effects of urbanization and captive tortoise release on wild tortoise populations. Because of the complex nature of ecosystems, each species has its unique role- thus disturbing the balance by introducing captive tortoises can be detrimental to the wild populations and the Sonoran desert.

F. Workshop Outreach Goals

The outreach goal of the Biological Pollution workshop is to raise awareness and public participation in the control of biological pollution of invasive species and re-introduced Desert Tortoise. We wish to inform the public about the threats of bullfrogs to native amphibian and reptile species, the dangers of changing the fire regime of the Sonoran Desert ecology with the introduction and spread of Buffelgrass, and the spread of Upper Respiratory Tract Disease in wild populations of Desert Tortoise by releasing diseased animals back into the wild. The Sonoran Desert ecology is complex and all the possible outcomes of introducing non-native species or disease into the ecosystem can not be definitively predicted. Raising public awareness to this fact, will help stem the tide of Biological Pollution in the future and hopefully, get the public more engaged in controlling the pollutants that have already established themselves in the Sonoran Desert.

G. Workshop Materials

Bullfrog Materials

1. Audio player
2. Bullfrog call mp3s
3. Informative poster
4. 25 gallon aquarium
5. live American Bullfrogs *Rana catesbeiana* (2 adult (1 male and 1 female), 2 juvenile
6. Hand sanitizer
7. Preserved specimens of bullfrog and leopard frog
8. 50 gallon aquarium
9. 1000 round beads/100 odd-shaped beads
10. 2' x 2' x 6" wooden frame
11. 2' x 2' piece of foam egg crating
12. blue spray paint
13. candy (preferably frog shaped)

Buffelgrass Materials

1. Two garbage bags of harvested buffelgrass
2. One cucumber or small personal sized watermelon
3. One box of wooden toothpicks
4. Fire extinguisher
5. Portable fire pit
6. Four small pieces of 1x1 wood approximately four inches in length
7. A dry branch from a creosote bush or other woody shrub
8. Lighter
9. Handout on invasive species
10. Informative Poster including images of pre and post buffelgrass invasion Sonoran Desert , and sight identification images of buffelgrass and native grass species
11. Post workshop survey to determine the effectiveness of the demonstrations and the information provided during the workshop

Desert Tortoise Materials

- 1.** Live tortoise or tortoise shell (*note: live tortoises may not be available due to hibernation status during winter months)
- 2.** Image of Mojave vs. Sonoran habitat for desert tortoises
- 3.** Poster collage game with mixed-up pictures of infected tortoises and healthy tortoises
- 4.** Green washable paint (or powdered chalk)
- 5.** Baby wipes
- 6.** Radio telemetry gear
- 7.** Clear Rubbermaid tub and dried grass to keep live tortoise in
- 8.** Native grasses and plants to offer tortoise
- 9.** Intact Box turtle shell for comparison
- 10.** Business card-sized handouts with information on Arizona Game and Fish contacts, instructions for what to do when encountering a desert tortoise in an urban area such as a neighborhood, adoption contacts, and a short list of citations for further research.
- 11.** Poster with pictures and text, organizing the threats captive tortoises pose to wild tortoise populations.
- 12.** Sonoran Desert Museum hand out with pictures and descriptions of the top invasive species threatening the Sonoran desert.
- 13.** Turtle-shaped candy

H. Workshop Preparation

Bullfrog Preparation

Egg clutch demonstration: Build the 2' x 2' x 6" wooden frame with no top or bottom. Cut foam egg crating to 2' x 2' square and color each reservoir of egg crating blue with spray paint. These will represent the 'ponds' for the 'frogs' to move through. The two sets of beads should be different colors and shapes. Label the 1000 round beads 'Bullfrog eggs' and the 100 odd-shaped beads 'Leopard Frog Eggs'.

Live Bullfrogs: Fill the aquariums with enough water for the frogs to be half submerged, add ground cover like dirt or gravel and place shelter in tank (rocks, branches etc.). Put adult bullfrogs in one tank and the juveniles in another (the adults may eat the juveniles).

Bullfrog calls: Queue the bullfrog audio to play in a loop of only the calls of the bullfrog and the leopard frog. Set at a volume that is not overbearing on your voice.

Buffelgrass Preparation

Insert the toothpicks into the cucumber or watermelon leaving about ½ the toothpick exposed to simulate the spines of a cactus. Arrange the wood in a square and mount the cucumber or watermelon on the square inside the fire pit (this will keep the "cactus" from rolling or falling over). Place your creosote branch next to your cactus so that the end of the branch is above the cactus creating a "nurse plant". Surround your cactus and nurse plant with buffelgrass. Make certain the Fire extinguisher is working and nearby.

Desert Tortoise Preparation

Presenter should make sure that the live tortoise is securely on a table or on the floor inside a large clear Rubbermaid bin. Adequate bedding (dried grass) should be available for length of presentation. Make sure that tortoise is shaded, if presenting outside and that it cannot climb out of the bin. Make sure to always supervise children while they are touching the tortoise. Have a shallow pie pan of paint or chalk dust to dip a light amount of color on hand for infection activity.

I. Activities

Bullfrogs

Egg Clutch Demonstration: Drop beads into 'ponds' and explain the significance of the bullfrogs moving farther than the leopard frogs. Since the bullfrog eggs are round, they will demonstrate the ability of bullfrogs to migrate farther than other frogs. Also note the number of bullfrogs in comparison to the number of leopard frogs, there should be a ratio of 10:1 to represent the 20,000 eggs laid per clutch in bullfrogs and the 2000 eggs laid per clutch in leopard frogs.

Explain the differences between males and females using the two adults. Males will have a yellow/green chin and throat while the females will have white coloring and very light green markings. The large circles located behind the eyes are the tympana (ear drums) and on the males these will be larger than their eye, and on the female the tympana will be about the same size as the eyes. The male thumbs on the forelimbs are very robust in comparison to the females' thumbs; the males' thumbs are this way to facilitate the copulation process. Instruct anyone who handles frogs to use hand sanitizer afterwards. Present educational material in the form of posters, lecture and audio of bullfrogs

Buffelgrass

Make sure your Fire Extinguisher is working and nearby. Light the buffelgrass on fire. Observe how quickly the grass burns and record. Observe what happens to your nurse plant and cactus and record. Finally, extinguish the fire completely and clean up. Do not perform the fire demonstration if wind gusts exceed 7mph or if there is a significant amount of brush or over-story that can be accidentally set ablaze.

Desert Tortoise

The disease-spreading activity will further instill the concept of infection outbreaks. The activity explains how tortoises could come into contact with wild tortoises. The presenter will spread green finger paint or powdered chalk on their hand to represent an infected turtle. The presenter (captive tortoise) will then shake hands to say hello to multiple audience members (native tortoise population). The presenter will then instruct the visitors to look at their hands, and everyone with green on them has become infected. Shaking hands represents how tortoises may come face to face in the wild and spread the disease through population. This contact could be in the form of male battle or from close proximity inside a den.

Show visitors the poster with pictures of sick and healthy tortoises. Ask audience members to identify all the sick tortoises.

Create a discussion encouraging children to think about how this lesson applies to other pet's release into the wild. Briefly discuss how scientists and agencies are trying to manage healthy wild tortoise populations and how they can help (ask kids how they are going to help).

J. Discussion Questions

- 1.** What is the importance of careful management and policy in the 'field' of ecology?
- 2.** What can you do, as an average citizen, to help fight against biological pollution such as the invasive bullfrog or buffelgrass problem?
- 3.** Why should the public care or know about the problems associated with invasive species?
- 4.** What other invasive species of plant are out there and what are their potential impacts to the desert?
- 5.** Should landscapers and garden shops be prohibited from selling potential invasive species?
- 6.** What control methods can be used and are currently underway?
- 7.** What research is the University of Arizona currently performing in relation to buffelgrass?
- 8.** What could be the consequences of releasing non native fish, water turtles or unwanted dogs into the wild?
- 9.** Should it be illegal for people to breed desert tortoises?
- 10.** If populations of desert tortoises disappeared, what effect would this have on other desert organisms?

K. Assessment

Public Survey Feedback

Bio-pollution; Josh Ruddick, Emily Kaleugher, Alex Lichtblau	Strongly Agree	Agree	Somewhat Agree	Not Sure	Don't Agree
The workshop enhanced my B2 visit	9	6			
The workshop was informative	10	6			
The workshop was professional and well put together	10	5			
I learned new concepts and information	10	4	1		
The workshop used appropriate visual aids	9	6			
The information was presented in a manner I could understand and relate to	9	4	2		
The presenters were engaging and showed interest in the topic	11	4			
I am now more likely to be involved in conservation efforts	6	5		1	1
I would like to see more of these types of activities at B2	9	5		1	
I would recommend this workshop to someone else	9	5			
How did you hear about this workshop?	Saw tables	Walking tour	Word of Mouth	Visitor's Center	
	2	1	1	9	
Gender	M	F			
	9	6			
How many in your group?	2	3	4	5	
	4	2	2	1	
Age	5 to 15	15 to 25	25 to 35	35 to 45	50 and up
		4	1		8
Where do you live?	Missouri	CA	Canada	Hermosillo, MX	Chandler, AZ
	1	1	1	1	1
	Phoenix	Montana	Catalina	St. Louis	
	2	3	1	1	

Public Comments

I learned many new things.

I learned lots.

Very interesting.

I learned how small the world is.

I learned some grasses to plant and what not to do with desert turtles and frogs.

I learned about a problematic “weed” that may be impossible to eradicate.

I would have liked to learn about other options to curb it, besides herbicides.

I learned that bullfrogs are not native to AZ and where the desert tortoise occurs.

I learned that buffelgrass contains a lot of fuel and may threaten cactus.

I would have liked to learn how more animals are adapting to certain environments.

I learned about specific invasive animals/grasses.

I would have liked to learn about successful introductions of non-natives.

I learned about how in the U.S. things were introduced...with good intentions, but ended up being horrible.

I learned a lot.

They were very friendly and into what they're doing.

I learned the government brought in invasive species that are taking over.

Great presentation; enjoyed the animals and plants.

I never heard about the imported bullfrog...didn't know they were a problem.

Well done: knowledgeable people.

I learned about pests our government introduced.

Great job! I learned lots and will get involved!

Peer-review comments

Anna's comments:

Good job relating to desert and what people are doing to harm it.

The engagement/receptivity was apparent with some more than others.

Everyone was relaxed and showed confidence which led to good communication: verbal and non-verbal.

Great info! You guys knew a lot of useful data.

Each member had their own table which worked well.

Since you had a lot of great data, you showed confidence and seemed relaxed.

Every table had something to touch, and a poster.

Having all of your visual and tactile components made this friendly to people of all ages.

Nice job using the posters! This was an area Janel and I needed to improve in!

Janel's comments:

Alex did a great job with connecting using prior background knowledge.

Try to interact more; don't throw too much info. at audience.

Emily sometimes used vocab that might be too advanced.

Try to "push" groups to other tables.

Very knowledgeable.

Candy was a great addition...love the turtles.

It would have been nice if there was a little more of a transition between each table.

I could really tell that the audience was learning a lot.

Pics on the tables might have been nice.

Josh: great job providing resources, good job answering questions, good visuals, good job bringing up current research at the U of A, great job providing good references for people to go to.

Emily: Good volume, great picture game!

Alex: Great to have live animals, and loved the sound effects! Good references to poster, nice visual with beads, audience was interested and excited; good analogies about distance.

Tiffany's comments:

Everyone looked great and interacted well.

Everyone did well seeking out personal connections.

Everyone seemed comfortable and relaxed.

Each person had their own table—this worked out well.

The pond game was cool! Emily's laminated tortoise game was also great!

A good number of kids—positive interactions.

Josh: great job answering questions.

A pointer would have been helpful to refer to posters...they were hard to reach.

I would recommend Josh have a diagram about grass morph.

People asked Alex for frog vs. toad info. A diagram or chart would have been helpful.

Good job everyone, with referring to your posters.

It was helpful that Josh had visitors touch parts of the grass to see differences.

Good job, Josh...of handing out business cards and referring to websites.

L. Refinement

Bullfrog – Alex Lichtblau

Apart from the last minute changes to the activities used in the workshop, like the egg clutch demonstration, most of the changes would be to minor presentation techniques and available materials. First of all I would add some visual aids to the table to show the differences between leopard frogs and bullfrogs, as well as possibly the differences between frogs and toads. These aids would help people solidify the concepts being presented and also add to the aesthetics of the setup. Another improvement would bring the poster closer to the table set up so as to allow the presenter to refer to it during lecture. Clear, large font labels on specimen jars, aquariums, egg clutch demonstrations and beads would also help reinforce ideas.

Buffelgrass – Josh Ruddick

In the future, the historical environmental context that led to the introduction of buffelgrass should be explained more clearly as well as the current efforts to resolve the issues presented by the buffelgrass invasion.

Desert Tortoise – Emily Kaleugher

The main changes I made to the desert tortoise section of the template, regarded the activities section. After running through my section of the workshop, I realized that the finger paint activity was not practical for the type of venue we were in and the crowds we were seeing. I would recommend this activity to be run in a classroom setting, or an outreach setting that had a large group of children and adults (12+ people) that appeared very engaged and were willing to stay for 20 or more minutes. Because we saw few children and the flow of the crowds was spotty, I did not feel that the audience I spoke with was interested in participating in such an activity. Furthermore, an audience of children sitting and participating in my section of the workshop may be better controlled (so as to not have rambunctious children running around unsupervised and wiping paint all over their friends). Therefore, I would make a note in the template of the circumstances in which this activity would work best.

The next change I made in the template was adding turtle-shaped candy on the table as an incentive to attract visitors to learn about desert tortoises and the Sonoran desert. I also added details as to how to play an interactive game that consisted of correctly identifying pictures of tortoises testing positive for Upper Respiratory Tract Disease. I felt that these big color pictures helped engage the

audience by touching at their emotions and helped them to better understand what a problem this disease could be to wild populations. I also adjusted the placement of the URTD poster into my workshop and made sure to include this activity quickly within my elevator speech; as a way to get the visitors interested. I noticed from the public feedback that my presentation was not one that strictly stuck in their minds while filling out the evaluation cards. Most people made broad statements about how they learned “a lot” or made references to buffelgrass and bullfrogs. Therefore I added this poster game into the activities section on the template as an activity that should be pushed and run.

M. Summary

Bullfrog – Alex Lichtblau

After having run the workshop for a live audience, I feel that we achieved our educational goals, which were to enlighten the public on issues of biological pollution and also to instill a sense of interest and involvement in the issues. Through the hands on experiences with live bullfrogs and the audio and visual props, I feel that I successfully connected with many of the audience members, and genuinely attracted attention to the subjects at hand. I think the audience members were excited about learning the information and some showed interest in volunteer bullfrog hunting expeditions. Despite how well I feel the workshop ran, there are a number of changes that would benefit both the audience and the presenter of this workshop.

Overall, I think the workshop ran very smoothly, and with more prior knowledge of the type of audience and more advertisement, it could have been even better. The public with whom I interacted seemed to truly enjoy learning the information and most of the public feedback came back very positively.

Buffelgrass – Josh Ruddick

Aside from the mock presentation, I performed this workshop twice (once at Biosphere 2 and once at the Tucson Botanical Gardens). In both cases I felt very comfortable with the content of the material and my ability to answer questions. However, at the Biosphere, I tended to point out the government intervention that introduced the problem of buffelgrass but failed to point out the historic context in which the grass was introduced as well as the governmental efforts to reverse the damage in recent years.

Aside from logistical difficulties with poster creation and parking, the workshop went off very well. I enjoyed the interaction with people and talking about the subject matter.

Desert Tortoise – Emily Kaleugher

Overall, I think our group worked so well because of our workshop design and size of our group. Since bio-pollution is such a broad topic, it was necessary to split it up into multiple projects and tables. I think that having more than two people in our group worked to our advantage and allowed visitors the chance to explore varying interests-whether they were curious about bullfrogs, buffelgrass, desert tortoises or all of the above! Additionally, having three group members plus our classmate's help allowed us to individually engage more visitors at a time.

N. Recommendations

Bullfrog – Alex Lichtblau

I think this workshop can be adapted to suit any type of audience or teaching environment. By putting emphasis on the visual, audio and tactile components, I was able to adapt it to a second grade classroom where the children really embraced the information and got excited about the topic. They learned all about the frogs themselves and also about the issue of releasing pets to the wild and the consequences. On the other hand, Josh Ruddick modified it only slightly by emphasizing the raw information and the metaphoric egg clutch demonstration, and successfully led the workshop at the Botanical Gardens which typically attracts an older audience. This audience, from what I am told, learned more about the overshadowing problem of invasive species and biological pollution.

Buffelgrass – Josh Ruddick

My primary recommendation for this workshop is to position it as part of the biosphere tour, thereby gaining more public participation. If the public believes the workshop is a part of the tour that they paid for, they are more likely to participate more actively. My second recommendation would be to target a different audience that may not be as engaged in science and learning as the visitors to the Biosphere or the Botanical Gardens may be. Suggestions for other workshops would include groups like Welcome Wagon, Meetup groups, Boy and Girl Scout troops, Rotary clubs, Toastmasters, as well as local area school districts.

Desert Tortoise – Emily Kaleugher

After applying all of our planned material into our completed workshop, I feel that I accomplished all the goals I set out to do. In order to accomplish these goals, I agree that having a condensed “elevator speech” was necessary to get across what I felt were my most important key points in a short amount of time (before some visitors lost interest). The sick tortoise ID game worked really well as an interactive activity of engagement that allowed visitors to see the raw effects that URTD has on wild tortoise populations. Having many items on my presentation table was a great way for people to come up and touch turtle shells or radio telemetry equipment and have a hands-on experience that facilitated many questions. Having cute turtle-shaped candy on the table also provided more incentive for visitors to come and check out my station- while feeling a bit obligated to at least listen to the elevator speech. I think that having fliers and information on topics outside of strictly the bio-pollution topic also came in handy. I found that the workshop was also a good vehicle for me to start conversations and gain visitors interest by answering questions about what kinds of native plants they can be fed and how someone can adopt a desert tortoise. Having everything labeled on the table was very important so that if I was speaking with another group of visitors, a newly joining group could explore the table on their own. Whether visitors were interested in the science/research aspect, physiology of turtles and tortoises, learning about how to better care for their tortoise, learning how they can help stop bio-pollution, or even just getting free candy, there was an opportunity for a variety of visitors to explore their unique interests. In the future, keeping lots of color photos and touchable items on the table is a must.

As mentioned in the refinement section, I found that the finger paint exercise was not practical in the setting at the Biosphere II. I think that this activity has the potential of being a great visual and physical way to reinforce the concepts of URTD transmission. I think that both children and adults could benefit from this activity, had there been a large group of visitors with many children and without time/interest constraints. Therefore, I think this activity is better suited for a classroom visit. Additionally, peer- feedback indicated that I may have used some advanced vocabulary when speaking with younger people about biological and ecological concepts. This may have intimidated some of my guests and may have affected how long they stayed at my table. In the future, I would try harder to limit the vocabulary and use terms that non-biologists could understand. I would also encourage the visitors to feel free to ask any questions, as they come up.

O. Elevator Pitches and Spanish Glossary:

Bio-Pollution

This workshop, created by U of A students in conjunction with the Department of Ecology and Evolutionary Biology and the Biosphere 2, is aimed at educating the public about the pressing issue of invasive species in our desert. Through hands-on activity and experience, we hope to inform the public about the bullfrog and buffelgrass invasions plaguing our landscape and spread of disease between captive and wild desert tortoises.

Sonoran Desert Discovery

Sonoran Desert Discovery is an Ecology and Evolutionary Biology course at the U of A aimed at creating educational workshops to be run at the Biosphere 2 facility. These workshops focus on engaging the public in current science issues through hands-on activity and student teaching and aim to raise awareness on science as it relates to the Sonoran Desert.

One-liners:

Bio-Pollution: The Biological Pollution workshop attempts to enlighten the public on issues like invasive and introduced species through hands-on activity and experience.

Sonoran Desert Discovery: Sonoran Desert Discovery is a course series at the U of A aimed at educating the public about interesting and current science associated with the desert.

Glossary with Spanish translations

Bio-pollution contaminación biológico

Species especies

Frog rana

Turtle tortuga

Grass hierba/zacate

Invasive invasivo

Introduced introducido

Prevent prevenir

Environment el medio ambiente

Protect proteger

Release poner en libertad

Predator predador

Burn arder

Fungus hongo

Disease enfermedad

P. Sources

Accessed October 1, 2009.

http://i.pbase.com/u35/tmurray74/large/33517067.256_5624_RT16.jpg

Accessed October 1, 2009 http://frog-shots.com/images/bullfrog_eating_treefrog_2.jpg

Accessed October 1, 2009

<http://www.fishpondinfo.com/photos/amphibians/bullfrogs/birdfrog2.jpg>

Accessed October 1, 2009 <http://pages.cthome.net/fwc/RCRANGE.GIF>

Rorabaugh, J. 2008. American Bullfrog *Rana catesbeiana*. Brennan, T. Accessed September 30, 2009. <http://www.reptilesfaz.org/Turtle-Amphibs-Subpages/h-r-catesbeiana.html>.

Accessed September 30, 2009. LizardTracks Productions.

<http://www.tucsonrana.com/>.

Accessed September 30, 2009. September 17, 2009.

http://en.wikipedia.org/wiki/Garter_snake

Accessed September 30, 2009. SBSC Bio: Cecil Schwalbe.

http://sbsc.wr.usgs.gov/about/contact/bio/schwalbe_cecil.aspx?id=199

Ficetola, G., Thuiller, W., Miaud, C. 2007. Prediction and validation of the potential global distribution of a problematic alien invasive species – the American bullfrog. *Diversity and Distributions*. 13:4:476-485.

Roach, J. September 28, 2004. Invading Bullfrogs Appear Nearly Unstoppable.

National Geographic News. Accessed October 5, 2009.

http://news.nationalgeographic.com/news/2004/09/0928_040928_bullfrog.html

<http://www.buffelgrass.org>

Narog & Wilson; Post-Fire Saguaro Community: Impacts on Associated Vegetation Still Apparent 10 Years Later; USDA, 1994

Alford, et al; Effects of Fire on Sonoran Desert Plant Communities; USDA; 2005

Fairfax & Fenham; The effect of exotic pasture development on floristic diversity in central Queensland, Australia; *Biological Conservation*, Volume 94, pp 11-21

Brooks et al; Effects of Invasive Alien Plants on Fire Regimes; *Bioscience*, vol. 54, No. 7, pp677-688

Nobel: Root Distribution and Seasonal Production in the Northwestern Sonoran Desert for a C3 Subshrub, A C4 Bunchgrass, and a CAM Leaf Succulent; American Journal of Botany, Vol 84, No 7, pp. 949-955

Averill-Murray, R. C. 2000. Status of the Sonoran population of the desert tortoise in Arizona: an update. Arizona Interagency Desert Tortoise Team and Arizona Game and Fish Department, Phoenix.

AZGFD. Desert Tortoise Management. 2009.

http://www.azgfd.gov/w_c/deserttortoisemanagement.shtml, accessed 9/28/2009.

Howland, J. 1994. Sonoran desert tortoise population monitoring. Nongame and Endangered Wildlife Program Technical Report 38. Arizona Game and Fish Department, Arizona.

Johnson, A., D. Morafka, E. Jacobson. 2006. Seroprevalence of *Mycoplasma agassizii* and tortoise herpesvirus in captive desert tortoises (*Gopherus agassizii*) from the Greater Barstow Area, Mojave Desert, California. *Journal of Arid Environments* 67 Supplement:192-201.

Jones, C., C. Schwalbe, D. Swann, D. Prival, W. Shaw. 2005. *Mycoplasma agassizii* in desert tortoises: Upper respiratory tract disease in captive and free-ranging populations in greater Tucson, Arizona. Final report to the Arizona Game and Fish Department, Phoenix, AZ. Heritage Fund Urban Project No. U03005.

Sandmeier, F., C. Tracy, S. DuPre, K. Hunter. 2009. Upper respiratory tract disease (URTD) as a threat to desert tortoise populations: A reevaluation. *Biological Conservation*. 142(7):1255-1268.

Upper respiratory tract disease in desert tortoises in relation to captivity and urbanization. 2008. *Sonoran Herpetologist* 21(10).

[For Further Information, or to get involved in helping control these elements of biological pollution Contact:](#)

Cristina Jones

Arizona Game and Fish Department
Turtles Project Coordinator
(623) 236-7767
cjones@azgfd.gov

Cecil Schwalbe

U of A School of Natural Resources

BioSciences East Bldg., Room 202
Tucson, AZ 85721

(520) 621-5508

cecils@email.arizona.edu

Buffelgrass.org

The Arizona Sonora Desert Museum

-Arizona Game and Fish website and volunteer information: www.azgfd.gov

-Tucson regional tortoise adoption/placement office:

Arizona-Sonora Desert Museum

ATTN: TAP

2021 North Kinney Road

Tucson, Arizona 85743

(520) 883-3062

www.desertmuseum.org/programs/tap.html