

ABSTRACTS – 2006
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Behavioral consequences of rattle reduction in island rattlesnakes

Three island endemic rattlesnake species in the Sea of Cortés have reduced rattle morphology. However, the consequences of this morphological reduction for defensive behaviors have not yet been studied. We recorded the behavioral responses of *Crotalus catalinensis*, *C. lorenzoensis*, and *C. estebanensis* to approach and capture in the field, during experimental manipulation, and in response to escalating threat during a controlled test. We then compared these responses to those from their nearest mainland relative (*C. ruber* and *C. molossus*, respectively) and a more distant outgroup species (*C. atrox*). There was no significant difference in the frequency or duration of rattling behavior between island species and their relatives. Island species were more likely to flee than to remain motionless and presumably cryptic, and made more attempts to flee before coiling into a defensive posture. However, the sequence in which behaviors occurred did not vary significantly from mainland relatives. Thus, rattling behavior and the context in which snakes rattle appear unchanged in island species despite complete lack of sound production in some individuals (*C. lorenzoensis*, *C. estebanensis*) or in a species (*C. catalinensis*).

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Less yolk makes a bloke: Multiple, interactive modes of sex determination in an alpine skink

In all vertebrate species studied to date, an individual's sex is determined either by genetic factors (GSD) or by the environment (ESD), or in rare cases by a combination of both mechanisms. In the alpine skink *Bassiana duperreyi*, however, the sex of a hatchling is determined by three separate factors. First, these lizards have GSD (XX-females and XY-males). Second, they also have TSD, because the GSD system breaks down when eggs are incubated in cool nests. Such nests produce mostly male offspring. Intriguingly, sex in *B. duperreyi* is also affected by a third factor: larger eggs are more likely to produce female offspring. How do

incubation temperature, sex chromosomes and egg size interact to determine offspring sex? Remarkably, egg size has a direct causal effect on offspring sex. Mothers produce variable sized eggs in a given clutch (average 22% intra-clutch range for egg mass), and smaller eggs tend to be sons rather than daughters. Experimental reduction of egg mass by yolk removal massively shifted offspring sex ratios towards males (89%, vs 55% in controls, 59% in sham-operated) at low incubation temperatures (characteristic of cool nests in the field, $16 \pm 7.5^\circ\text{C}$) but not at high incubation temperatures ($22 \pm 7.5^\circ\text{C}$; hot nests). Hence, the sex of an individual in this lizard population reflects a complex interaction among genes, incubation temperature and maternal yolk allocation. Existing paradigms on sex determination in reptiles may be too simplistic, and the possibility of widespread multifactorial systems requires further investigation.

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The "Carolina" Redhorse (*Moxostoma* sp.), an undescribed Carolina
endemic

The "Carolina" Redhorse is a rare, undescribed member of genus *Moxostoma* (Catostomidae) restricted to the Pee Dee and Cape Fear river drainages in North and South Carolina. R. E. Jenkins recognized the species in 1995 and proposed it as sister to the Golden Redhorse, *M. erythrurum*, a widely distributed species occurring in the Mobile, Mississippi, Great Lakes, and Hudson Bay drainages, as well as on the Atlantic slope in the James and Roanoke drainages with a probable introduction in the Potomac drainage. No form similar to this distinctive redhorse was known south of the Roanoke drainage prior to 1995. While the "Carolina" Redhorse shares several features allying it to the Golden Redhorse (e.g., shape of lips, breeding tuberculation, nuptial and non-nuptial colorations, and spawning behavior), several anatomical and fixed genetic differences attest to its distinctiveness and validity as a separate taxon. Since 1996, intensive sampling efforts have been mounted using backpack and boat electroshocking to refine knowledge of the range and age structure of this elusive species. These investigations found that the species is very rare and prefers larger bodies of water, appearing on shoals (to spawn) only very briefly compared to other species of *Moxostoma*. These factors may work jointly to reduce the vulnerability of the "Carolina" Redhorse to collecting techniques in wadeable areas and perhaps partially explain their rarity in collections. Here we present the history of discovery, current known distribution of this Carolina endemic, as well as preliminary genetic information concerning its phylogenetic placement within *Moxostoma* based on cytochrome-*b* and S7 intron sequence data. Results of this genetic work indicate that the species may be introgressed or of hybrid origin.

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Bioeconomy of the shark fishery on the western coast of Baja California Sur, Mexico

In Mexico, the shark fishery is very heterogeneous since it is multispecific, a wide diversity of fishing gears, and artisanal and commercial fishermen are present. Thus, the fishery management is difficult. In the matter, Días-Urbe and Ramírez-Aguirre (2002) proposed the Importance Bioeconomic Index (IBI), which sort hierarchically the resources of a multispecific fishery based on the catch, value and fishing season. In the present work, IBI was modified adding the concept of Vulnerability, which involves anthropologic pressure and species fragility, to locate the most important bioeconomic fishing areas of the shark fishery at the western coast of Baja California Sur, Mexico. Using logbooks from 1996 to 2001 and a geographic information system we located, by its high commercial value and vulnerability, the areas in front and to the north of Magdalena Bay (25° - 26° N and 113° - 114° W) as prior and we recommend management steps.

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Anatomy and functional morphology of the feeding apparatus of white-spotted bamboo sharks, *Chiloscyllium plagiosum*

Anatomical investigation of the feeding apparatus in white-spotted bamboo sharks, *Chiloscyllium plagiosum* reveals many characters associated with inertial suction feeding such as labial cartilages to occlude the lateral portions of the gape and hypertrophied hypobranchial musculature to power hyoid depression against high negative pressures generated in the buccal cavity during suction feeding. Manual manipulation of the hyoid arch in these sharks identifies the medial hyoidiomandibular ligament as a possible biomechanical link convergent with the mandibulohyoid ligament in bony fishes and aquatic feeding salamanders that couples lower jaw depression with hyoid depression. Together, the medial hyoidiomandibular ligaments and ceratohyals form force amplifying second order levers that – during initial hyoid depression – may assist in lower jaw depression by harnessing force generated by the coracohyoideus and coracoarcualis and transferring it to the lower jaw where it will assist the coracomandibularis in generating posteroventral rotation. Later in hyoid depression the ligaments and ceratohyals form force amplifying first order levers that rotate the proximal ends of the ceratohyals and transfer force to the hyomandibula resulting in ventromedial compression of the distal ends of the

hyomandibula. This action also causes medial compression of the jaw halves and anteroventral movement of the jaws in a manner that differs from that reported in *Orectolobus maculatus*. The mechanics of the hyoid arch mentioned above may be beneficial to suction feeding by amplifying the force generated by the coracohyoideus and coracoarcualis and transferring it to skeletal elements of the buccal cavity that experience the most displacement during the expansive phase. This may allow *C. plagiosum* to rapidly depress the lower jaw and expand the buccal cavity against negative pressures that may be as high as 100kPa.

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An analysis of dietary preferences in five sympatric frog species

Anurans, as a whole, are considered to be dietary generalists. If this is the case, one might assume that frog species similar in size and occurring in similar habitats are competing with each other for the same prey. In this study, we examined the diets of five frog species to determine the degree of prey overlap. The species studied were *Acris crepitans*, *Gastrophryne olivacea*, *Hyla chrysoscelis*, *Pseudacris clarki*, and *P. streckeri*. These species appear to be relatively similar in size and are found occurring together in north-central Oklahoma. Stomach contents of museum specimens were identified to order or more specifically when possible. Prey length was measured if whole prey items were present. Snout-to-vent length and gape width of frogs were measured as these are two of the main morphological features which determine what a frog can consume. When diets were compared among frog species, only the pairs *H. chrysoscelis* & *P. clarki* and *H. chrysoscelis* & *P. streckeri* were not different from each other. There were no differences among four of the frog species in the length of prey consumed except between *G. olivacea* & *P. clarki* and *G. olivacea* & *P. streckeri*. *Hyla chrysoscelis* was not included in this part of the study due to the scarcity of measurable prey items found in stomachs of available specimens. All frog species were different from each other in snout-to-vent length except *G. olivacea* & *P. clarki*, and all five species were different from each other in gape width. These conclusions suggest that perhaps frogs are more specific in prey selection than previously believed in order to reduce competition with other anuran species. The species used in this study differ from each other in morphology, perhaps providing a functional explanation for how they avoid dietary overlap.

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A new *Eremias* (Sauria: Lacertidae) from the Zagros Mountains, Hamedan Province, western Iran

A new and distinctive form belonging to the genus and subgenus *Eremias* Fitzinger, 1834 is reported from the highlands of Alvand Mountains, Hamedan Province, western Iran at about 2700 m elevation. It is easily distinguished from all the other species of the typical subgenus (*E. velox*, *E. persica*, *E. strauchi*, *E. nigrolateralis*, *E. lalezharica*, *E. afghanistanica*, *E. regeli*, *E. suphani*, and *E. nikolskii*) by having a variable number of postmentals (4-5 pairs), smaller size, and distinctive color pattern. Furthermore, it can be distinguished by having a combination of characters against any of the species in the typical subgenus. Further work, using both morphological and molecular techniques, is now being carried out on this new form in order to determine its exact taxonomic and phylogenetic status. Systematics of the genus *Eremias* is shortly discussed.

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Rediscovery of the Eastern Fire Salamander, *Salamandra Infracinnata* *Semenovi* (Caudata: Salamandridae), from Kurdistan Province, western Iran

Based on extensive field work and research in the central and northern Zagros Mountains, Kurdistan province, western Iran, the presence of the *Eastern Fire Salamander*, *Salamandra Infracinnata* *Semenovi* Joger and Steinfartz, 1995 is reconfirmed. This subspecies mainly occurs in the alpine meadows at the elevations between 1200-1900 m, relatively close to the mountainous streams and brooks. Taxonomy and distribution of the eastern fire salamanders are shortly discussed and the importance of rediscovery of this taxon is explained.

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Population structure and hybridization of *Etheostoma caeruleum* (Actinopterygii: Percidae) in the Ozark Highlands

The rainbow darter *Etheostoma caeruleum* is widely distributed in streams of eastern North America. In the Ozark Highlands of Missouri and Arkansas, multiple lineages within this polytypic species have been identified from both morphological and genetic data. Mitochondrial data indicate that populations have pronounced phylogeographic structure among Ozark stream systems, with marked subdivisions between adjacent streams. Further, phylogenetic relationships are consistent with a combination of historical and present stream drainage connections. Mitochondrial data also indicate that *E. caeruleum* hybridizes with sympatric species, particularly *E. uniporum*. An additional molecular data set using microsatellites was generated to determine if the mitochondrial genetic diversity pattern was corroborated by nuclear data, and if

nuclear introgression occurred among hybridizing species. Significant population structuring was found among sampled *E. caeruleum* populations, consistent with previous genetic work, which suggests that mitochondrial markers are reflective of the distribution of genetic variation in this species. This pattern confirms previous morphological and molecular data indicating that *E. caeruleum* populations are highly subdivided in Ozark Highland streams.

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Long term perspective of Lake Erie watersnake color polymorphism

The microevolutionary processes acting on color pattern of Lake Erie watersnakes (*Nerodia sipedon insularum*) have been well documented. Variation in color pattern is heritable and is influenced both by gene flow from mainland populations of *N. s. sipedon* and natural selection by visual predators within island populations. We used historic data collected prior to 1961 and recent data collected from 1980-2003 to characterize fine-scale spatial and temporal variation in color pattern. We integrated our results with previous allozyme-based estimates of F_{ST} to assess the degree to which fine-scale variation exceeds that expected due to neutral processes. Morph frequencies did not differ significantly within islands or between islands separated by short distances. Morph frequencies did sometimes differ significantly among more distantly separated islands and among sampling periods from 1980 to the present, but no more than expected given patterns of allozyme variation. In contrast, a marked change in morph frequency has occurred between historic (prior to 1961) and recent (1980-2003) samples. The cause of this change is unclear but may include changes in the strength of selection due to changes in predator assemblages and visual environments or changes in rates of gene flow due to changes in island watersnake population size.

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Effect of habitat degradation on corticosterone levels and parasites in aquatic turtles

Habitat degradation is one of the primary causes for reptile declines. In the United States, over 53% of original wetlands have been destroyed due to human encroachment. Terrestrial areas adjacent to aquatic habitats are critical for many reptiles to complete their life cycles, yet these habitats are often not protected. In turtles, terrestrial habitat degradation has been shown to lead to abnormal population structures, reduced population size, and lower genetic variability, however, the effects on turtle health remain largely unstudied. In goal of this study was to examine the effects of habitat degradation on turtle glucocorticoid levels, and ecto- and hemo-parasites. During the summer of 2005, we trapped 434 turtles from 44 ponds with varying levels of terrestrial habitat degradation in IL. Baseline and stress-induced levels of corticosterone were measured from 200 slider turtles (*Trachemys scripta*). Additionally, we examined leech and hemoparasite prevalence and intensity on snapping turtles (*Chelydra serpentina*), painted turtles (*Chrysemys picta*), and slider turtles (*T. scripta*). The overall prediction is that habitat degradation will be associated with reductions in turtle health.

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Modeling critical breeding habitat and sexual dimorphism in the endangered spotted turtle (*Clemmys guttata*)

Identification and protection of critical habitats (e.g., breeding and nesting sites) are essential to species conservation. Previous studies have investigated habitat use and home range sizes of the federally endangered spotted turtle (*Clemmys guttata*), but components of critical breeding habitats have not been quantified. In species for which the breeding strategy involves male-male competition, males tend to be larger than females. Spotted turtles aggregate in spring to breed, which may facilitate male-male competition and female mate choice; but the details of the species' mating strategy are unknown. We are developing two models to examine critical breeding habitat and mating strategies, as indicated by sexual dimorphism, in spotted turtles. The predictive habitat model will quantify, using known long-term study sites and new sites, environmental variables (e.g., water depth, canopy cover, vegetation stratification) of spotted turtle breeding sites, and can be applied in species conservation efforts. Spotted turtles show sexual size dimorphism with respect to facial and eye colour, and plastron shape, but not in regards to carapace length and width. Using morphometric analyses, we will examine the direction and degree of sexual dimorphism and make interpretations with respect to the species' mating strategy. From these morphology investigations, it may also be possible to sex juvenile turtles, which do not show secondary sex characteristics, and make inferences about the fecundity of females.

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Trophic basis of production and energy flow associated with emergence among assemblages of larval ambystomatid salamanders in forested ponds in southern Illinois

Larval amphibians transfer energy from freshwater to terrestrial ecosystems during seasonal emergences, but larval production and energy flow to adjacent systems are rarely quantified. During 2003-2004, we derived prey-specific assimilation efficiencies, conducted gut analyses, and intensively sampled ambystomatid salamander assemblages in four forested ponds to quantify energy flow associated with larval consumption and assess the importance of major prey types to production and emergence. We estimated that 2.5-17.2 g AFDM m⁻² yr⁻¹ of prey production was required to account for larval salamander production, which ranged from 0.8-5.3 g AFDM m⁻² yr⁻¹ among assemblages. Energetically important prey types varied among populations and ponds, with up to 88.5% of *A. opacum* production attributed to zooplankton, 84.2% of *A. maculatum* production attributed to aquatic insects, and 79.3% of *A. tigrinum* production attributed to amphibian prey. Overall, zooplankton accounted for 60.4-88.5% of salamander production in temporary ponds whereas aquatic insects accounted for 19.9-84.2% of production in permanent ponds. Emergences associated with larval assemblages represented 3.3%, 4.8%, and 8.2% of consumption and 9.9%, 15.8%, and 26.4% of production at three ponds that did not dry during larval development. Our study demonstrates that emergences of larval amphibians represent a significant pathway for energy flow from freshwater to terrestrial food webs. Quantifying the ecological roles of amphibians is important in light of amphibian declines, as this information furthers our understanding of the ecological consequences of these losses.

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Color and pattern variation in the Peacock Bass *Cichla temensis* (Cichlidae)

The South American genus *Cichla* has a problematic taxonomy. Although taxonomists currently believe there are five species, additional undescribed species may exist. The taxonomy is further confounded by the existence of many strikingly different color and morphological pattern variants within *Cichla* and particularly *Cichla temensis*, the largest and most commercially important of the species. To elucidate the nature of these color and pattern variants, a multi-part study was performed between these patterns and gonad maturity. Specimens

were collected in floodplain rivers within *C. temensis* native Amazon habitat in two widely separated regions; the Rio Igapo Acu (Rio Madeira drainage) and the Rio Caures (Rio Negro drainage). A graduated scale of color and pattern ranges was developed using a compilation of previously taken photographs from a large sample of over a thousand specimens of *C. temensis*, collected throughout its range. Freshly captured study specimens were graded according to this color scale, photographed, weighed, measured, sexed and GSI determined. Initial analysis of the data shows a strong relationship between color and pattern variation and GSI and indicates that the different morphs represent changes within individuals related to seasonal spawning cycles. This information may help to clarify some of the issues affecting the taxonomy of species in this genus, and their ecology and management.

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Foraging success of cyprinids along a turbidity gradient

Increases in suspended sediment in clear water environments negatively impact freshwater fishes in various ways, including reduced spawning and foraging success. However, suspended sediment may not be detrimental to all fish species, in particular, those that live in naturally turbid environments. Today, some drainages with historically high turbidities (e.g., rivers of the Great Plains and Colorado River) tend to be clearer due to sediment trapping by dams and reduced flows. The loss of turbidity and the role it plays in the decline of fishes in these rivers has received little attention. Species within these drainages are hypothesized to have a number of morphological traits that allow them to be successful in turbid environments. These fishes may depend on high levels of suspended sediment for survival (e.g., feeding, reproduction, or protection from sight-feeding predators). I investigated the effects of turbidity on the foraging success of fishes from clear and turbid systems in Oklahoma and Texas. My prediction was that as turbidity increased, feeding success of turbid-water fishes would be constant while clear-water fishes would decrease. Feeding trials were performed in 40 liter fish tanks at the University of Oklahoma Biological Station. Nine cyprinid species were tested for the number of bloodworms consumed in five minutes across five turbid treatments. Turbid-water fishes fed well in all treatments, but clear-water fishes ate significantly less at higher turbidities. These results imply that turbid-water fishes have an advantage in locating food in highly turbid environments. Thus, decreased suspended sediment loads in historically turbid rivers (via dams) may have reduced the foraging advantage of turbid-water fishes and contributed to their decline.

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Gene expression in thermally stressed environments

Fishes in the genus *Gambusia* commonly thrive in environments that expose them to large fluctuations in temperature and oxygen availability. Diurnal temperature cycles may include changes of 20°C and seasonal temperatures may range from near freezing to approaching 40°C; however, it is not clear whether these populations respond to high temperature extremes via a chronic stress-response or if they have adapted to these extreme conditions. Populations of *Gambusia* spp. were collected from constant moderate thermal environments (i.e., springs) and thermally stressed environments (i.e., shallow rivers/creeks without shade in regions with ambient summer temperatures over 40°C). Fish were exposed to varied temperatures and quantification of the expression of genes involved in stress mediation was determined by real-time PCR. Additionally, analysis of protein coding Hsp sequences were compared for levels of variability and ratios of nonsynonymous to synonymous substitutions calculated to test the effects of natural selection. Results from this experiment elucidate the adaptive significance of variation in gene expression in natural populations of organisms.

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Constraint and the evolution of a Caribbean anole, *Anolis cristatellus*

A previously unexplored dimension of the anoline radiation in the neotropics is the importance of quantitative genetic constraint in morphological evolution. This study uses a phylogenetic approach to assess the importance of constraint on phenotypic differentiation of populations of the Puerto Rican crested anole, *Anolis cristatellus*. We find evidence that the form of constraint is conserved over evolutionary timescales and furthermore that genetic constraint significantly influences the pattern of phenotypic divergence.

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Geographic barrier to dispersal of *Tropicolotes* (Gekkonidae; Sauria)

Genus *Tropicolotes* Peters, 1880 was ten species that disperse from North Africa to Middle East. Dispersal of two species is African-Asian, but dispersal of three species closed to north-Africa and dispersal of five species closed to western

Asia. For geographic barrier used the climate and ecological factors. But during this study affects of climatic factors as well elevation and temperature in each region from Africa to Asia is important rather than other factors. Results of geographic analysis have been divided into three parts that comprised of: I: ITCZ barrier avoid to dispersal of *Tropicolotes* from north-Africa to equator, II: Anatolia plateau extend to Zagros and Elburz MTs in Iranian plateau are important barrier to dispersal of *Tropicolotes* to high latitudes, III: Tibet plateau at the strongly barrier to avoid of dispersal of *Tropicolotes* to eastern Asia. In other hand, Indian rain before the Tibet plateau has the important role to avoid dispersal of *Tropicolotes* to Tibet plateau. Consequently dispersal of this genus is closed due to geographic changes during geographic evolution. Therefore a result of geographic analysis to barrier of this genus has shows dispersal closed to north hemisphere in tropic hot-dry climate. Stabilize dispersal of herpetofauna during evolutionary pathway at the results of Natural selection as well genus *Tropicolotes* due to climatic factors during climate evolution.

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Management implications for squaretail coralgrouper, *Plectropomus areolatus*, in Pohnpei (Micronesia) from tagging surveys

Throughout the Indo-Pacific, (fish) spawning aggregations (FSA) of squaretail coralgrouper, *Plectropomus areolatus*, are threatened by overfishing. Only two countries – Palau and Pohnpei (Micronesia) – have instituted protective measures for the species' FSA through commercial sales bans during parts of the reproductive season and marine protected areas. To investigate the effectiveness of area protection (no-take Kehpara Marine Sanctuary, KMS) for squaretail coralgrouper FSA in Pohnpei, 647 individuals were tagged with spaghetti-type tags, including 40 acoustically tagged sex-specified individuals at an aggregation site. Within a 12-month period, 9% of all tagged fish were recaptured, with 32.7% re-captured within KMS by the investigators and an additional 43.1% captured outside the KMS by fishers within the reproductive period. Of those captured outside the sanctuary, 79.1% with known catch locations were taken within a 10-km area proximate to the FSA. Acoustic data suggest common migratory pathways for individuals to reach FSA sites and show high site fidelity, as well as inter-monthly and inter-annual return to the FSA by both sexes. Results indicate a high vulnerability of squaretail coralgrouper to overfishing during reproductive periods by the removal of individuals at FSA sites, along migratory pathways and areas proximate to FSA sites. Data further suggest that, within Pohnpei, management of squaretail coralgrouper could be improved by an extension of the existing sales ban and implementation of a catch ban corresponding to the actual reproductive season of squaretail coralgrouper and/or area protection that includes all FSA sites and respective migratory pathways.

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Amphibian site occupancy in four hydrologic regimes in the Florida Everglades

The Comprehensive Everglades Restoration Plan (CERP) requires the use of indicator species to measure the success of restoration efforts. The Everglades amphibian community is an ideal ecosystem restoration indicator because amphibians are present in all habitats and under all hydrologic regimes. Randomly selected plots in four distinct hydrologic strata within the Everglades ecosystem were chosen to sample amphibians from July 2004 to August 2005. Three sampling methods (nighttime visual encounter surveys (VES), vocalization surveys, and trapping) were used to capture amphibians. Trapping was done with PVC pipe refugia and funnel traps that were checked during the day. We used program PRESENCE to estimate site occupancy of the amphibian species. This site occupancy model when applied to randomly chosen sites in a defined area can be used to represent an estimate of the proportion of area (PAO) occupied by a species. We detected fourteen amphibian species during VES, vocalization surveys and trapping, and were able to estimate site occupancy on seven of those species: *Acris gryllus*, *Hyla cinerea*, *Hyla squirella*, *Rana grylio*, *Rana sphenoccephala*, *Notophthalmus viridescens piaropicola*, and *Siren lacertina*. There was a distinct difference in detection of amphibians on the two dry sites compared to the two wet sites. On the two dry sites, many species were detected immediately after the onset of the wet season and occurred for a short time period. On the two wet sites, few species were detected year round. Site occupancy rates for *A. gryllus*, *H. cinerea*, *R. grylio*, and *R. sphenoccephala* were all 100% for every site. The results from this project will allow managers to evaluate Everglades restoration efforts, establish restoration targets, and compare restoration alternatives.

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Variation in metamorphic timing can be induced by variation in density without difference in growth rate in the frog, *Rana utricularia*

Optimality models for understanding the timing of amphibian metamorphosis predicts that a growing larva will delay metamorphosis in order to take advantage of a good growth opportunity. Conversely, a deteriorating larval habitat is predicted to induce metamorphosis. We tested this hypothesis by growing larval *Rana utricularia* in 11 X 5.5 X 3.5 inch containers filled with 2600 ml of reverse-osmosis [RO] water that held 1, 2, 4, 8, 10, or 20 tadpoles. Every 3 days, tadpoles were fed a per capita 25 mg aliquot of a finely ground 1:1 mixture of rabbit chow and fish food flakes, i.e., the 1-tadpole treatment received a 25 mg aliquot whereas the 10-tadpole treatment received a 250 mg aliquot at each feeding. After 3 months, the aliquots were tripled. Three months after the food

increases, one-half of the treatments were subjected to a food reduction that returned these treatments to a per capita 25 mg aliquot. Thus we used a full-factorial two-factor design manipulating density (6 levels) and food reduction (2 levels) for total of 12 treatments each replicated six times (for a total of 450 tadpoles in 72 containers). We analyzed metamorphic timing and mass of all transforming tadpoles with a two-way MANOVA with density and food as treatment effects. Inspection of growth curves and analysis of mean tadpole mass showed no significant differences in growth, as intended by the equivalent per capita food treatments. Food-reduction failed to induce differences in metamorphic timing. Tadpole metamorphic timing differed significantly when comparing the 4-tadpole with 20-tadpole treatments. This means that tadpole density can affect metamorphic timing without requiring a growth-rate transduction of tadpole density.

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Population history and genetic affinity of two populations of the U.S. endangered Dusky Gopher Frog

Anthropogenic habitat fragmentation and reduction are major causes of population declines and local extinctions. As habitat fragmentation and loss intensifies across the landscape, population subdivision of non-human organisms typically occurs. The most severe consequence is complete geographic isolation of populations. Isolated populations tend to become inbred and genetically differentiated from each other. Two populations of the US Endangered Dusky Gopher Frog, *Rana sevosa*, exist. These populations have been geographically isolated by ca. 32 km for an unknown time, presumably less than a century. Long-term demographic data and genetic data exist for one population, whereas the other population was only recently discovered and has unknown demographic and population genetic status. The population with known status is somewhat protected because it is located in the De Soto National Forest, Mississippi. The other population is located on private land with multiple owners. Habitat surrounding the newly discovered breeding pond is not protected. Our research objectives were (1) to determine genetic variation in the newly discovered population and compare it to that of the population with known demographic and genetic status; (2) to test for severe, historic reductions in population size of the newly discovered population; and (3) to assess genetic affinities between the two populations. Genetic analyses were performed using genotypic data of seven microsatellite DNA loci for individuals of the newly discovered population (five eggs from every egg clutch deposited during two separate breeding seasons) and previously collected microsatellite DNA data of the other population. Results of this research will be discussed in the context of species management. One potential management strategy is to transplant eggs or larvae from the newly discovered population to historic breeding sites. These data will aid in our decision of whether or not sites are chosen to allow mixing of individuals of these two extant populations.

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No monster: Sighting of an anuran (*Bufo* sp.) in the deep water of Loch Ness

Video recordings made with a remote underwater vehicle in Loch Ness produced a serendipitous finding – the presence of a bufonid anuran resting on the substrate at approximately 95 m below the water surface. The recorded water temperature at that depth varied from 4-5 °C, and the pressure approached 10 atm. The frog appeared initially lethargic but moved in response to the presence of the remote vehicle. Although *B. bufo* is found in that region of Scotland and is known to over-winter in springs/ponds, this is the first record of this species, or any amphibian, inhabiting this depth of water. Similarly, while the ability of this species to overwinter at that temperature is not unusual, its ability to withstand high pressure for such an extended period of time is unprecedented. We will present video footage of this encounter, and welcome feedback from physiologists interested in studying this system.

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Feeding habits of the sandpaper skate, *Bathyraja kincaidii* (Garman, 1908), from central California, U.S.A.

The sandpaper skate, *Bathyraja kincaidii*, is a small deep-sea batoid that most commonly occurs from depths of 200-500m from the Gulf of Alaska to Baja California. As with most eastern North Pacific skates, few studies have been done on the life history of this species. Examination of 130 sandpaper skate stomachs collected from central California by the Southwest Fisheries Science Center (SWFSC) Santa Cruz Lab (SCL) from 2002 to 2005 revealed that like most other skates, this species has a generalized diet, feeding on many different groups of prey. They fed predominantly on invertebrates such as euphausiids, small shrimps, cephalopods and polychaetes. In addition, myctophids, rockfishes, crabs and mysids were also in the diet. Multivariate analyses were used to test for differences in both proportional weight and number of major prey groups (shrimp-like crustaceans, polychaetes, teleosts, small benthic

crustaceans, crabs and cephalopods) by sex, maturity status and oceanographic season (Upwelling, Oceanic and Davidson Current). Diets were significantly different among seasons, explaining the largest proportion of the variance in the diet. All major prey groups, except cephalopods, showed differences among seasons. Diets also differed between maturity stages, which accounted for the next greatest proportion of the variance. Higher proportions of polychaetes, small benthic crustaceans and crabs were consumed by immature skates, while mature skates preyed more on shrimp-like crustaceans and teleosts. Feeding habits differed significantly between sexes, but only for weight data, and was driven by the higher proportion of shrimp-like crustaceans, small benthic crustaceans and crabs in male diets.

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Phylogeographic analysis of the federally endangered Etowah Darter

The Etowah darter, *Etheostoma etowahae*, is a recently described member of the *E. (Nothonotus) jordani* species group believed to be geographically restricted to the Upper Etowah River in Georgia. Small population sizes and restricted range present potential risks to the continued existence of this endangered species. The most geographically proximal records of the relatively abundant greenbreast darter, *E. jordani*, were reported from Stamp Creek (a tributary to the middle section of the Etowah River); however, in recent surveys *Nothonotus* individuals have been documented from intermediate localities and appear to be morphological mixtures of *E. jordani* and *E. etowahae*. Two alternative hypotheses may explain these findings: these newly discovered localities may indicate syntopy and/or hybridization between these two species, or alternatively, morphological characters promoted in the formal species description of *E. etowahae* may be problematic and incapable of definitively identifying all *Nothonotus* specimens from the Etowah River. Either call raises questions as to the classification status of these newly documented populations and the true geographic ranges of these sister species. In this study we have sequenced 2019bp of mtDNA from 120 *Nothonotus* specimens to provide a means for genetic identification of *E. etowahae*, examine population structure, and redefine geographic distributions for each species. Phylogeographic analysis documents *E. etowahae* haplotypes in areas approximately 110 river kilometers downstream from where it was first described in 1993. *E. jordani* haplotypes appear to be allotopically distributed in four river systems. Surprisingly, little phylogeographic structure is found within either of these species throughout their respective ranges.

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Movements of translocated and resident three-toed box turtles

Translocation of terrestrial turtles mitigates habitat loss, increases population size or genetic diversity, and establishes new populations. The success of many translocation efforts often depend on social and economic factors, but ecological factors may also affect translocation success. We used radio-telemetry to evaluate Three-toed Box Turtle (*Terrapene carolina triunguis*) movements before and after translocation from a continuously forested site to a highly fragmented site, and made comparisons to resident turtles. The average distance moved between consecutive 28 hour relocations (dismove) pre-translocation versus post-translocation depended on turtle origin. Turtles from the continuously forested site had similar average dismove to resident turtles at the fragmented site prior to translocation, but had increased average dismove following translocation. Translocated turtles traveled greater total distances, had greater net displacement, and greater home range size than resident turtles. Additionally, translocated turtles had directed movements, whereas resident turtles did not. We considered density or competition with resident turtles, habitat structure at the release site, and homing as potential explanations for the observed differences. Homing behavior or directed movement towards continuous forest adjacent to the release site may account for the movement patterns observed. Future translocations should consider the landscape context of the release sites as well as the landscape context of the original capture location.

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Defining terrestrial habitat use and summer refuge sites of wood frogs in oak-hickory forests

The importance of terrestrial habitat for the conservation of pond-breeding amphibians has recently been emphasized in the literature. We examine the terrestrial habitat use of an isolated, relic wood frog (*Rana sylvatica*) population in Missouri. Wood frogs spend most of their life in moist woodlands, with yearly breeding events lasting only 2-5 days in temporary wetlands. Our study population is located at the extreme southwestern edge of the range in mature, oak-hickory forest. This habitat differs greatly from the boggy, boreal woodlands that occur throughout the majority of the wood frog range, which spans across Canada and the northeastern United States. We hypothesize that summer

refuges with moderate microclimates may be an important habitat requirement in the southern portion of their range. We radio tracked 42 adult wood frogs as they emigrated from 3 breeding sites. The movement paths indicate that wood frogs in Missouri use rocky drainages as summer refuges. These drainages must therefore provide similar microclimates and resources as the forested wetlands used as summer refuges in northern portions of the wood frog range. In addition, we used conditional logistic regression to describe the microhabitat use of wood frogs at a 2 m scale. Light and humidity were important microclimate variables, with litter depth and canopy cover being important structural variables that likely create optimal micro-climates. Finally, we used univariate kernel estimation to describe the similarities and differences in movement distances between three breeding populations. We found that the distance between the breeding site and nearest drainage may be an important landscape complementation feature for predicting wood frog habitat use. Conservation of important terrestrial habitat for local amphibian populations is enhanced by knowledge of species-specific information. In addition, terrestrial habitat use may vary within a species at different locations within its range.

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A first approach towards resolving systematic relationships among families of Gadiformes fishes using mitochondrial and nuclear genes

The order Gadiformes includes some of the world 's most important commercial fish species (e.g. Atlantic cod, haddock, pollock, silver hake, among others species). They range from Arctic to Antarctic waters in all oceans, occurring from mostly deep-sea benthic to coastal waters. Additionally, exist two estuarine species and one species occurs in fresh water habitats. These species present high vulnerability associate with some life-history traits such as their late maturation, extreme longevity, low fecundity, and slow growth. Despite its commercial importance, the taxonomy of this complex group of fishes is poorly understood. Most of the information is available for the commercially important species, while for the vast majority of species in the order data is scarce, if anything. Most of the works done on the classification problems within the Gadiformes have been based on morphological characters. Currently, some authors recognize anywhere from 11 to 14 families, about 75 genera, and more than 500 species in the group. In 1948, wrote: "... a detailed revision of the gadoids is extremely necessary". Although there have been some efforts to sort the taxonomy of the Gadiforms, a consensus has still not been reached. Thus, 58 years later the revision asked for by Svetovidov is still as necessary. This provides an excellent opportunity to implement a molecular phylogenetics study comprising most of families in the order. For this purpose, we obtained nuclear (RAG1) and mitochondrial (12S and 16S) sequence from several genera in the group,

attempting the widest taxonomic coverage possible. The results of our study represent the first attempt to resolve family level relationships using mitochondrial and nuclear DNA sequence data.

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Genetic and environmental sources of variation in growth between
Sceloporus populations in Florida: faster growth from cooler environments

Plasticity in life history traits is often examined along elevation gradients or between distant populations where environments have obvious differences. Because the climatic gradient associated with latitude in Florida is less extreme, though still marked, it provides an opportunity to examine plasticity in traits at a finer scale. Using populations of *Sceloporus undulatus* and *S. woodi* from both north (cooler) and south (warmer) Florida, I examined the influence of environment and source population utilizing a common housing experiment. I incubated eggs and then raised hatchlings for 8 weeks under identical conditions, subsequently releasing them in the habitat from whence they came for a mark-recapture experiment. All populations had faster growth rates in the common environment than in their source habitats, but only *S. undulatus* populations grew significantly faster. Source population significantly affected growth rates in *S. undulatus* during the common housing experiment, suggesting a genetic component of growth that is different between these populations that are only 100 miles apart. Overall, individuals from cooler environments grew faster than individuals from warmer environments, whether measured while in their source habitat or in the common lab environment. Microhabitat temperature regimes and food availability were measured at each of the source habitats and compared with the constant regimes of the common environment in relation to growth.

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Hybridization, extinction risk, and ecological correlates in the endemic
Florida Scrub Lizard *Sceloporus woodi*

Recent attention has been focused on the ability of hybridization and introgression to cause extinction, especially when highly fragmented small populations of one species come into contact with a wide-spread congener, which is exactly the case with *Sceloporus* in Florida. The fence lizard, *Sceloporus undulatus*, is the wide-spread congener of the endemic Florida scrub lizard, *S.*

woodi, which occurs in highly fragmented populations throughout Florida. We are collecting lizards from pure species zones and a suspected hybrid zone to determine the proportion of F1 and F2 generation hybrids and backcrosses of hybrids with each parental species within the hybrid zone. Thirty-five years ago, this hybrid zone was examined using a discriminant analysis on morphological traits. We plan on contrasting the discriminant analysis with our genetic data to determine the accuracy of this morphological approach, which will allow us to examine geographic changes in the hybrid zone over the last thirty-five years, estimate the velocity of introgression, and evaluate the potential for genetic assimilation of *S. woodi*. Environmental data (canopy cover, bare ground, temperature, habitat heterogeneity, and tree and shrub species) is also being collected across the ecotone with the GPS recorded point of capture for each lizard to examine ecological correlates with genealogical class. The environmental data will give us insight into habitat use by hybrids, potentially pinpointing habitat features that can be managed to change dynamics of the hybrid zones. Our hypotheses are that 1) hybridization is occurring, 2) the hybrid zone is narrow and stable, and 3) the environmental gradient explains the gradient of genealogical classes, and therefore the narrowness of the hybrid zone and the continuing distinctiveness of each species. Preliminary results suggest that hybrids occupy areas with higher mid-canopy heterogeneity than that found in *S. undulatus* habitat.

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Resource use among sympatric gar species (Lepisosteidae) in the middle Brazos River and associated oxbows

The middle Brazos River, located in east central Texas, is a meandering lowland river that contains many oxbow lakes on its floodplain. Flood dynamics of the Brazos River are aseasonal, and due to this unpredictable hydrology, faunal exchange from lateral connection of the main river channel and oxbows is pulse like and only occurs during floods that may be months or years apart. From this study, resource use among sympatric gar species (*Lepisosteus oculatus*, *L. osseus*, and *Atractosteus spatula*) was studied for a period of two years (May 2003 to May 2005), in which the first year was a relatively dry year (few lateral connections) and the second year was a relatively wet year (more frequent lateral connection). The study focused on habitat and diet partitioning among the three gar species between two oxbow habitats and an active channel site. Overall 684 gar were collected with experimental gillnets: 19 *A. spatula* (alligator gar), 374 *L. oculatus* (spotted gar), and 291 *L. osseus* (longnose gar). There was strong partitioning of habitat between spotted and longnose gar, in which 98% of spotted gar were captured in oxbow habitats and 84% of longnose gar were captured in the river

channel overall. During the wet year, habitat partitioning was weaker with longnose gar, where 31% were captured in oxbows (compared to 3% during the dry year). Spotted gar distributions were not effected dry or wet years where 99% and 97%, respectively, were captured in oxbow habitats. Because there was such high degree of habitat partitioning, there was very little diet segregation between species. There was, however, a difference in diet composition between sites due to the differences in prey assemblage structures.

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Shorefishes of the tropical eastern Pacific: An online information system

In 2002 a CD-based dual interface (English/Spanish) information system on the Shorefishes of the Tropical Eastern Pacific was produced by the Smithsonian Tropical Research Institute. That has now been redeveloped as an online dual interface system powered by Discover Life (www.discoverlife.org). As well as providing the most current data available, this online system provides enhanced analytical capabilities over those in the original CD-based system. This online system will be demonstrated for the first time at the ASIH 2006 meeting. That system covers 1261 species, 494 genera and 141 families of shorefishes. Its facilities include various identification aids (2200+ color photographs that cover 83% of the species, text descriptions, interactive multi-entry keys, common name search, an engine that uses data on location and morphology, and comparisons of similar taxa). Links between taxa and relevant citations in the 1150 item library allow interrogation of that database. Other databases contain information on biological characteristics of all species: size, habitat, depth range, diet, reproduction, latitudinal/longitudinal range size, Cites/Redlist status. Database maps provide visualization of range distributions and latitude/longitude of collection-record sites. The map engine allows comparisons of ranges of multiple species; visualization of the distribution of species richness; the assembly of lists of species with chosen characteristics at single sites (user defined spatial scale) or of species shared/not shared between paired sites; and lists of local endemics(i.e.species found only in a selected area).

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How many shorefishes in the tropical eastern Pacific?

The Tropical Eastern Pacific (TEP) is a strongly isolated biogeographic region with a high level of endemism among its modestly-sized (<1,300 species) known fauna of shallow-water shore-fishes. We examined accumulation curves of descriptions of these fishes, which began in 1758, to assess if they can be used to predict the total size of that fauna. The species description rate has remained fairly constant over the past century, and there are no signs that an asymptote is being approached in accumulation curves for groups of species that comprise the bulk of the fauna. However, curves of pelagic and multi-habitat species (22.5% of the fauna) may be nearing asymptotes, perhaps because those species are relatively easy to collect. Although these accumulation curves indicate that the total TEP fauna is distinctly larger than the presently known fauna, they do not allow prediction of that total. We extrapolated from body-size frequency distributions of different types of species among the known fauna to estimate how much larger the entire fauna might be. Poorly sampled areas of the TEP that represent priority targets for investigation include habitats below normal-SCUBA depth, two isolated island groups, and several continental areas with diverse and unusual environments. We used current levels of taxonomist activity to assess how long the description of known un-named species could take. The exploration work needed to assess the abundance of unknown species and provide a clearer indication of faunal size likely will take considerably longer.

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Dietary analysis of the longnose skate, *Raja rhina* (Jordan and Gilbert, 1880), in California waters

The longnose skate, *Raja rhina*, is one of the most important incidental species landed in central and northern California demersal fisheries. However, life history information is extremely limited for this species and aspects of its diet and feeding habits are unknown. Feeding ecology studies can provide researchers with important insights towards understanding potential fishery impacts on marine systems. The primary objective of this study was to analyze the feeding ecology of *R. rhina* off the coast of central California. Specimens of *R. rhina* were collected between September 2002 and August 2003 from fisheries-independent trawl surveys conducted by the National Marine Fisheries Service, South West Fisheries Science Center (NMFS-SWFSC). Of 1,193 longnose skates caught, 527 were female and 666 were male. A total of 618 *R. rhina* stomach samples was processed, and all prey items were identified to lowest possible taxa. For every stomach, the percentage of each prey item by number (%N) and weight (%W) were calculated and averaged to obtain a mean value. These measures were combined with the overall percent frequency occurrence (%FO) to determine the Index of Relative Importance (IRI), represented as %IRI. Results indicate that the five most important prey items were unidentified teleosts (31.6% IRI), unidentified shrimps (19.6% IRI), unidentified euphausiids (10.9%

IRI), Crangonidae (7.4% IRI), and *Neocrangon resima* (6.0% IRI). *Raja rhina* diet was further analyzed through comparison of the following intraspecific variables: gender (male/female), depth (shelf/slope), and size class (<600 mm/>600 mm), using Morisita's Index of Overlap. This analysis indicates there is a high degree of overlap between gender (95.9%) and shallow depths (96.4%), while size classes overlapped very little (34.8%). Additional multivariate statistics, Principle Component Analysis and MANOVA, are currently being conducted to further assess potential differences in diet among intraspecific variables.

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Speciation and biogeography of *Haemulon* (Teleostei: Haemulidae) inferred from nuclear and mitochondrial genes

The new world genus *Haemulon*, collectively known as grunts, is comprised of 19 nominal species and occurs in tropical and subtropical reefs along both sides of the Americas. Fifteen species are found in the western Atlantic, and five in the eastern Pacific with one being shared by both regions. The main diagnostic character of *Haemulon* is the presence of scales covering the soft dorsal and anal fins. Even though most species are small, grunts are edible, valued as food, and some are commercially important. Aiming to elucidate the phylogenetic relationships between the species of *Haemulon*, we obtained a combined total of <1,800 base pairs from two mitochondrial genes (cytochrome b and cytochrome oxidase I), one nuclear intron (TMO-4C4) and one nuclear gene (RAG2) from all nominal species. Some of the previous morphology-based phylogenetic hypotheses, such as the close relationship among *H. aurolineatum*, *H. boschmae* and *H. striatum* based on fin-ray counts, were not supported. Our data also indicate that the trans-isthmian *H. steindachneri* is composed of two species, one in each side of the Americas, and we propose the revalidation of the Atlantic species. The closure of the Isthmus of Panama seems to have played a role in the diversification of *Haemulon*, however, many sister species pairs have completely overlapping geographical distributions, indicating that vicariance is not the main process driving speciation in this genus.

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Herpetofaunal diversity of four protected areas in upstate South Carolina

The upper piedmont and mountain regions of South Carolina have been exposed to decades of intensive logging and/or agriculture. Within the last eighty years, significant portions of these regions have been protected and allowed to reenter vegetative succession. Many of these protected areas have not been surveyed for herpetofaunal diversity. The purpose of this study was to develop a checklist of species occurrence and to calculate a measure of diversity for four parcels of protected land in the upstate of South Carolina. Two types of surveys were conducted over a three month period during 2004. Coverboard surveys and time constrained searches were conducted weekly or biweekly at all sites. Both the presence and number of each species of reptile or amphibian observed were recorded. The Shannon-Weaver Index of diversity was calculated for each site as a measure of species level diversity. A few species composed the numerical

majority of observations, leading to a relatively low measure of species evenness at most sites, despite higher levels of species richness. All sites had similar level of species diversity, though different sites were occupied by different assemblages of species. Further, more extensive studies of the same sites are planned and will include auditory monitoring of amphibian breeding sites, road cruising surveys, the placement of pitfall trap/drift fence arrays, and increased coverboard monitoring.

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Age and growth of juvenile Bluefish in southern New England estuaries

Decreasing abundance of bluefish observed in recent years has led to an increased interest in better understanding the early growth of young-of-the-year (YOY) bluefish and the importance of estuaries in juvenile development. During the summer and early fall of 2004 and 2005, juvenile bluefish were collected by beach seine from 3 sites in Southern New England. Sagittal otoliths were used to determine birthdates and weekly growth rates for each fish. Field collections were coupled with laboratory validation experiments using tetracycline-injected fish. Birthdate back-calculations show 1 summer-spawned cohort present in both years with birthdates from late May to early July. A linear relationship was found between otolith radius and body length. This relationship was fitted to the Fraser-Lee, body proportional hypothesis (BPH) and scale proportional hypothesis (SPH) back-calculation equations. Validation studies show no evidence of uncoupling and that the Fraser-Lee equation appears to be most appropriate for juvenile bluefish. Average growth rate for juvenile bluefish in southeastern Massachusetts is 1.4 mm fork length per day, which was constant over the course of the summer. Juvenile growth rates did not appear to vary between locations in southeastern Massachusetts or be influenced by size at juvenile metamorphosis.

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Trade in vertebrates: What is the potential for homogenization?

Biological homogenization decreases global species diversity through species extinctions and introductions. The live vertebrate trade contributes to homogenization as the primary pathway for vertebrate introductions. Successful establishment of vertebrates is determined primarily by the number of individuals released or release events, known as propagule pressure. Based on

this concept, potential propagules and subsequent homogenization through introductions should be related to the number of individuals imported and species richness per vertebrate taxon in trade. We utilized a subset of the international vertebrate trade, United States importation/exportation data from 1970–2002, to estimate how many individuals and species for 5 taxa (amphibians, turtles, squamates, crocodilians, birds) were moved through this pathway. For each taxon, we plotted the cumulative number of species imported from 1970–2002, projected species accumulation to identify the point at which all species will have been traded, and regressed the cumulative number of established species versus the cumulative number of species imported. If the current exponential rate of species accumulation we found continues, we predict that the United States will trade all turtle, crocodilian, and squamate species in less than 75 years. The potential for homogenization through introductions is greatest for taxa with the highest proportion of their global species traded. We found an increasing relationship between the cumulative number of established species versus the cumulative number of species imported per taxon. Our results indicate that data from the live vertebrate trade can provide an informative and predictive framework for discussion of the relationship between trade and vertebrate introductions.

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Compensatory growth in the sandbar shark, *Carcharhinus plumbeus*: Fact or fiction?

Numbers of sandbar sharks, *Carcharhinus plumbeus*, in the Northwest Atlantic have experienced drastic declines since the early 1980,s reaching their minima during the early 1990,s. Catch rates in the early 1990,s were a mere 25% of those during the 1980,s. Such drastic reductions in other fish stocks have often caused compensatory responses, most notably the cod stocks in the Northwest Atlantic. Compensatory responses in depressed populations may include decreased natural mortality, increased fecundity, or increased growth rates. Compensation for population fluctuations below carrying capacities have been recognized for many terrestrial and oceanic r-selected organisms, but few instances have been noted for K-selected species. Due to slow-growth and late maturity, compensatory responses in K-selected species such as the sandbar shark probably require generation-scale time periods to become evident. A previous age and growth study discovered slight increases in juvenile sandbar shark growth rates when vertebral centra samples obtained in 1980-81 and 1990-1992 were compared. The Virginia Institute of Marine Science shark long-line survey reported the lowest abundance of sandbar sharks in 1992. Animals pupped during this time may display greater differences in growth rates due to drastically reduced population size. Samples obtained over the 2001-2004 time

period were compared to the aforementioned time periods to investigate potential compensatory responses in the sandbar shark population in the Northwest Atlantic.

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Site fidelity of water moccasins inhabiting a catastrophic environment: Results of an 11-year study

An 11-year mark-recapture study of water moccasins was conducted at Honey Creek, a limestone spring-fed stream with a channeled streambed in Comal County, Texas. Droughts and nine flood events during the study dramatically altered flow with floods raising water depth by five m. Fifty-seven snakes were marked along the 1564 m long study area during 57 searches. Marked snakes were recaptured 109 times. Subsequent analysis of capture/recapture data thru the 11-year period was used to a) describe the population size structure and sex ratio, b) determine whether this population was comprised of transients, and c) determine how this putative sit-and-wait predator used space in this linear and highly dynamic system. Thirty-nine snakes were deemed sexually mature, 14 were subadults, and 4 were juveniles. The sexes did not differ in recapturability but females outnumbered males (2.3:1). Adults were recaptured more frequently than young snakes. Twenty-one (37%) were not recaptured, and 25% were captured four or more times. Seventy-one % of snakes had tenure times in the system of 1 year or less, however, following this precipitous drop, the percent of snakes potentially available to be recaptured 2 to 11 years following initial capture declined modestly. Eleven years after marking, 12.5 percent of snakes potentially available for recapture were recaptured. Distances moved between successive captures and distances from the mean capture point showed that use of the area by snakes was not random. Distances moved did not vary with sex, number of times captured, or time between captures. Because snakes were found in a limited area through several major flood events, we posit that those able to do so, if displaced, quickly returned to their activity areas.

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Finding Wright's Westbury

In three papers published between 1918-1919, famed Cornell University herpetologist Albert Hazen Wright described his capture of a rare bog turtle on August 13, 1916 at Westbury near Oswego, apparently in Wayne County New York while in the company of two soon to be eminent biologists and scholars. In

his Notes on the Muhlenberg's Turtle, Wright (1918a) states that "At Westbury, N.Y. (west of Oswego, N.Y.) Messrs. F.P. Metcalf, Ludlow Griscom and myself took a specimen (carapace about 6 cm. long) in an open moor-like area on August 13, 1916." Notes on Clemmys (1918b) and Turtles and Lizards of Monroe and Wayne Counties, New York (1919), provides similar accounts. Biologists with the NYS Department of Environmental Conservation, the Fish and Wildlife Service and us could not determine site specific information on where Wright and spent this day in August of 1916. Testament to the site's indeterminate location can be found in David E. Collins's confidential field report (1989) to the DEC on his surveys of western and central NY bog turtle sites which states that "one site (Westbury) could not be located". After considerable research and field work, we captured a live bog turtle from a fen in Wayne County in the town of Westbury in June of 2004, roughly 88 years after Wright and his eminent companions made there only known visit to this site. This talk will rehearse the steps and mis-steps associated with what we believe to be the re-discovery of Wright's long lost Westbury site.

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Deep coral bank fish communities along the southeastern United States continental slope

Deep-water coral habitats are scattered throughout slope depths (350-800 m) off the southeastern United States (SEUS). Deep corals contribute substantial structure and diversity to bottom habitats. In some areas (e.g., off NC) deep corals (nearly monotypic *Lophelia pertusa*) form high profile mounds, and in other areas (e.g., off Jacksonville, FL) they may colonize existing hard substrates. Data on the fish communities of deep coral ecosystems are lacking, especially from off the SEUS. We surveyed the fishes of deep coral banks along the continental slope between Cape Lookout, NC and Cape Canaveral, FL using the Johnson-Sea-Link submersible (2000-2005, 65 dives) and otter trawls. We have identified at least 80 benthic and benthopelagic fish species on and near coral habitats along the SEUS. The fish assemblage on deep coral habitats differed from non-coral habitats in similar depths. The primary, coral habitat was dominated by *Laemonema melanurum*, *Hoplostethus occidentalis*, and *Beryx decadactylus*. Off reef, *L. barbatulum*, *Fenestraja plutonia*, and *Myxine glutinosa* dominated. Additionally, fish assemblages exhibited significantly (ANOSIM, Global R=0.64, p=0.1%) different geographic patterns with NC stations forming a distinct group that differed from two southern groupings (Central-off SC through northern FL, and Southern-off Cape Canaveral, FL). Species driving the assemblage off NC included *B. decadactylus* and *H. occidentalis*. Off SC through north FL, species drivers included *Nezumia sclerorhynchus* and *L. melanurum*. *Synaphobranchus* spp. and *F. plutonia* were drivers in the most southern site (Cape Canaveral, FL). Differences in fish assemblages seem to be most related to depth and the structure of coral habitat.

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Migration and vertical movements of a tagged Atlantic goosefish on Georges Bank

Depth (pressure) and temperature measurements recorded on a data storage tag (DST) were examined from a single Atlantic goosfish, *Lophius americanus*, tagged on Georges Bank on 9 December 2003 and recaptured 192 days and 113 km away off Cape Cod, Massachusetts on June 18 2004. The monkfish exhibited a strong pattern of periodic vertical movements ranging from 4 to 209 m (mean=75 m) with durations of 96 to 912 minutes (mean 225 minutes). A total of 43 vertical movements were recorded averaging 1.6 movements per week. Two periods of frequent daily movements were recorded. The first period occurred over six weeks in February and March during a transition from deep (180 m) to shallow water (150 m), while the second period apparently occurred as the fish descended into the Great South Channel and then ascended up the western slope into the inshore waters of Cape Cod over a five week period in May and June. Vertical movements during the second period were consistently longer in duration (mean = 246 minutes) and higher in elevation (132 m), than those in the first period (mean duration = 179 minutes, mean height = 41 m, respectively). The rate of ascent and descent were similar with means of 1.0 m/minute and 1.2 m/minute, respectively. Vertical movements occurred primarily between 0000 h and 1200 h (81 %), with peaks at 0300 h and 1000 h. This data suggests that Atlantic goosfish exhibit at least three modes of movements: 1) gradual movements along the bottom contour, 2) more rapid movements involving short vertical hops of less than 10 m height, and 3) large vertical movements involving vertical jumps of 10-200 m and durations 8 hours. The latter pattern suggest extensive use of tidal transport mechanisms.

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Movements and body temperature variation in free-ranging midland painted turtles (*Chrysemys picta marginata*) in a north-temperate marsh on Beaver Island, Michigan

We used surgically implanted radio-transmitters to study body temperature (T_b) variation and movements of Midland painted turtles over three summers (2003-2005) in a small north-temperate marsh system. On sunny days, T_b increased sharply during the late morning hours and then declined throughout the late afternoon, early evening, and early morning hours. Variation in T_b was relatively low on cloudy days. Mean daily T_b was positively correlated with mean daily water temperatures in all years. Mean daily water temperatures varied significantly among years and apparently as a consequence, mean daily T_b also varied significantly between 22 and 26 C annually. There were no differences in mean T_b between sexes within or between years. Turtles moved within relatively well-defined activity centers within the home range. Mean total daily distance moved (TDDM) varied between 81 and 110 m per day annually and was positively correlated with T_b in 2003 and 2004. We found no significant differences in mean TDDM among years or between sexes.

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Molecular phylogenetics and evolutionary diversification of labyrinth fishes (Perciformes; Anabantoidei)

Labyrinth fishes (Perciformes; Anabantoidei) are primary freshwater fishes with a disjunct African-Asian distribution that exhibit a wide variety of morphological and behavioral traits. These intrinsic features make them particularly well suited for studying patterns and processes of evolutionary diversification. We reconstructed the first molecular-based phylogenetic hypothesis of anabantoid intrarelationships using both mitochondrial and nuclear nucleotide sequence data to address anabantoid evolution. The mitochondrial data set included the complete cytochrome b, partial 12S rRNA, complete tRNA Val, and partial 16S rRNA genes (3332 bp) of 57 species representing all 19 anabantoid genera. The nuclear data set included the partial RAG1 gene (1494 bp) of 21 representative species. The phylogenetic analyses of a combined (mitochondrial + nuclear) data set recovered almost fully resolved trees at the intrafamily level with different methods of phylogenetic inference. Phylogenetic relationships at this taxonomic level were compared with previous morphology-based hypotheses. In particular, the enigmatic pike-head (*Luciocephalus*) was confidently placed within the *spiral egg clade*, thus resolving the long-standing controversy on its relative phylogenetic position. The molecular phylogeny was used to study the evolution of the different forms of parental care within the suborder. Our results suggest that the evolution of breeding behavior in anabantoids is highly correlated with phylogeny, and that brood care evolved three times independently from an ancestral free spawning condition without parental care. Ancestral character state reconstructions under maximum parsimony and maximum likelihood further indicated that both bubble nesting and mouthbrooding have evolved recurrently during anabantoid evolution. The new phylogenetic framework was also used to test alternative biogeographic hypotheses that account for the disjunct African-Asian distribution.

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Small fish in a big clade: A molecular perspective on gobioid phylogeny

Gobies (Perciformes; Gobioidae) are small fishes normally between 4 to 10 cm (range 1 to 50 cm) inhabiting most freshwaters, brackish, and marine habitats

with the exception of the Antarctic and Arctic Ocean and the deep sea. The suborder Gobioidae comprises eight families (Rhyacichthyidae, Odontobutidae, Eleotridae, Gobiidae, Kraemeridae, Xenisthmidae, Microdesmidae, Schindleriidae) with about 270 genera, and approximately 2200 species. They show a spectacular variety in morphology, colouration, behavior, and ecology. While gobies belong to one of the most species rich fish groups, roughly 10% of all ray-finned fishes are gobies, they are at the same time one of the least known. A robust phylogenetic framework for gobies, one of the most species rich vertebrate clade, is needed to tackle their evolutionary history (e.g. systematics, biogeography, species richness patterns, and modes of speciation). Morphology based phylogenetic reconstructions (e.g. vertebral and pterygiophore pattern, palatopterygoquadrate complex, sensory papillae pattern) have recently been complemented by molecular approaches. The high number of species, and the current lack of consensus regarding gobioid intrarelationships makes it difficult to design efficient sampling strategies to address their phylogeny. In an attempt to contribute towards the gobioid tree of life, we have obtained nucleotide sequence data of a 2200 bp region that includes the mitochondrial 12S rRNA, tRNA-Val, and 16S rRNA gene from over 250 species, complemented by nuclear DNA loci. While an attempt has been made to represent all major gobioid lineages, we focus mostly on the American seven-spined gobies (Gobiosomatini) and on European (East Atlantic, Mediterranean, Ponto-Caspian) gobies.

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Reproductive habits of round gobies in the Erie watershed

The round goby (*Neogobius melanostomus*) is a small benthic species native to Eurasia. It has been introduced outside its native range to several different regions, most recently to the Laurentian Great Lakes. The fecundity and reproductive behavior of the round goby has been found to differ in the various habitats it has invaded. This study estimated the fecundity and reproductive potential of the round goby in both the benthic and lotic waters of Lake Erie throughout the 2002 and 2003 reproductive seasons. In Lake Erie the average number of goby eggs per nest was approximately 1000 including immature and eyed up eggs. The average number of eggs per female during the breeding season was 217 counting both mature and immature eggs. The average fecundity for lake (161) vs. stream (87) gobies were compared as were gonadal somatic indices.

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Habitat partitioning between the introduced round goby and native stream fishes in the Lake Erie drainage of Pennsylvania

Round gobies *Neogobius melanostomus* have been found to have detrimental effects on native fish populations in the Great Lakes Region. Preliminary research has implicated them in the extirpation of the mottled sculpin (*Cottus bairdi*) and the eastern sand darter (*Ammocrypta pellucida*), and the decline of the Johnny (*Etheostoma nigrum*) and Iowa darters (*Etheostoma exile*). Under experimental conditions, they have been found to prey on other benthic fishes. It is also suspected that they compete with native species for food and habitat. Although these preliminary studies suggest that round gobies are having negative effects on native fishes, no direct evidence has been documented. Habitat partitioning could give direct evidence of this effect. The purpose of this study is to examine partitioning between non-game native benthic Lake Erie (darters, madtoms, and sculpins) stream fishes and to determine if there was a shift in habitat usage of the native fishes when round gobies were present in Twenty-mile Creek, Lake Erie. Twenty-mile Creek is the largest of the eastern tributaries to Lake Erie in Pennsylvania. Previous studies have demonstrated that in the Pennsylvania waters of Lake Erie, Twenty-mile has the most diverse benthic fauna of any stream in this drainage. Also, a small waterfall prevents goby movement upstream, allowing us to compare areas where gobies are both present and absent. We electrofished 50m areas both above and below the waterfall. Percent composition, population estimates, and Simpson diversity indices were calculated for each site. The interaction habitat preference study was conducted by three skin divers who began snorkeling at the downstream end of the sites and made their way slowly upstream. Following a benthic fish observation, a numbered, colored flag was secured into the stream bed at the specific locality of each of the fish. Flag color indicated the species of fish sighted. Following the snorkeling session, the following abiotic variables were recorded at each flag: depth (cm), water velocity (m/s), substrate size, distance from shore, and distance from the origin of the site. Preliminary analysis indicates that in the areas where round gobies were present, there was a shift in habitat usage by native fishes.

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Population genetics of Saltwater Crocodile (*Crocodylus porosus*) in Palau

The Saltwater Crocodile, *Crocodylus porosus*, is a wide-ranging Indo-Pacific species. The Republic of Palau is home to what appears to be one population of this species. We are presently conducting a molecular genetics study of the wild population in Palau to determine if Palauan crocodiles are composed of one or more separate species; if the population reflects the genetic influence of other crocodilian species, which may have been introduced into the population in the past; and to create a genetic profile of Palauan crocodiles. We compare the genetics of Palauan saltwater crocodiles to that of other crocodilians living within the natural geographic distribution of *C. porosus*: *C. mindorensis*, *C. novaeguineae*, and *C. siamensis*. A circa 620 basepair fragment of the mitochondrial control region revealed a single, unique haplotype among the 37 *C. porosus* individuals sampled on Palau, most closely related to a haplotype sampled in Australia. Microsatellite genotypic data at nine loci further reveals low levels of variation relative to populations on larger landmasses, including Australia and Papua New Guinea. Based on these preliminary results, the Palauan crocodiles represent a unique population of *C. porosus*, with no measurable genetic influence from additional crocodilian species introduced over the last 200 years.

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Reproductive allometry in the common map turtle, *Graptemys geographica*

According to optimal egg size theory, natural selection pressures balance the egg size/clutch size trade-off at a point where increases in maternal body size result in increases in clutch size but not increases in egg size. Many turtle species show increasing egg size with increasing maternal body size, however. The anatomical-constraints hypothesis explains this pattern by hypothesizing that smaller females lay smaller-than-optimal eggs because of morphological constraints; larger eggs simply would not pass through the pelvic aperture and caudal gap of the shell. We examined relationships among female body size (measured as plastron length), clutch size, and egg size for a population of common map turtles (*Graptemys geographica*) on Presque Isle State Park in Erie, Pennsylvania. Correlation analyses were conducted using log-transformed data in order to address questions of isometry and allometry. Clutch mass increased isometrically with plastron length. Egg size and clutch size were both significantly negatively allometric in their relationship with plastron length. It appears that larger females split the increased reproductive allocation made possible by increased maternal volume devoted to eggs between increasing both clutch size and egg size, consistent with predictions of the anatomical-constraints hypothesis.

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Taxonomy and systematics of *Nemadoras*, a genus of Neotropical thorny
catfishes (Siluriformes: Doradidae)

Eigenmann (1925) established *Nemadoras* for *N. elongatus* (Boulenger), type species, and *N. bachi* (Boulenger). Sabaj and Ferraris (2003) expanded the genus to five valid species, *N. elongatus*, *N. hemipeltis* (Eigenmann), *N. humeralis* (Kner), *N. leporhinus* (Eigenmann) and *N. trimaculatus* (Boulenger), and synonymized *N. bachi* with *N. humeralis*. Molecular evidence (Moyer et al. 2004) and new morphological data support the inclusion of *Opsodoras ternetzi* Eigenmann in *Nemadoras*. Recent museum and fieldwork uncovered a new species of *Nemadoras* in the upper Amazonas and Meta (Orinoco drainage) river systems. The new species is diagnosed in part by its tooth and barbel morphology and coloration. *Nemadoras* is tentatively diagnosed by a unique combination of characters: barbels fimbriate, teeth present in lower jaw (sometimes lost in adults), nuchal foramina present and enclosed by supraoccipital, epioccipital and middle nuchal plate, anterior nuchal plate absent or reduced and enclosed by supraoccipital and middle nuchal plate, middorsal and midventral accessory plates absent, and snout relatively short, rounded to weakly pointed (not long and conical). *Nemadoras* is one of few doradid genera in which the anterior nuchal plate is sometimes absent (others being *Physopyxis* and adult *Rhynchodoras*). Other interesting features include ontogenetic changes in tooth expression and convergences in color patterns with other syntopic doradids. These features along with the taxonomy and systematics of *Nemadoras* will be presented.

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All catfish species inventory (ACSI): Midterm report

In September 2003 the National Science Foundation Biotic Surveys and Inventories Program funded the first Planetary Biological Inventory (PBI) entitled: All Catfish Species (Siluriformes) - Phase I of an Inventory of the Otophysi. The mission of this PBI project is to complete the classification of

Siluriformes by facilitating the discovery, description and dissemination of knowledge of all species by a global consortium of taxonomists and systematists. Components of the project include exploration and fieldwork, taxonomy and classification, systematics and evolution, digital museums and libraries, new applications of technologies (HRXCT or 3D scanning) to morphological studies, publications, education and public outreach, conservation, and a variety of collaborative work and partnerships with other NSF funded projects. As of 1 March 2006 ACSI has 360 participants and correspondents (including 110 students) at about 180 institutions/organizations in 48 countries; and has contributed \$419,575 to participant research (44%), fieldwork (32%), and publishing (7%), and type imaging projects (17%) at a number of museums. Nearly 1,500 primary catfish types have been imaged at over 30 museums and 4,490 catfish images are available on-line to project participants. Highlights from ACSI's first half include the description of a new family of catfishes (Lacantuniidae) from Chiapas, Mexico, publication of a special 2005 issue of Neotropical Ichthyology (28 new species and one new genus resulting from 19 papers contributed by 30 authors), a near trans-continental expedition across Peru and Brazil (50-70 new catfishes collected by 29 participants from five countries), and submission of a molecular phylogeny (based on nuclear genes rag 1 and 2) for 35 of the 37 families of catfishes. A summary of ACSI's midterm progress will be presented as well as a call for new projects on poorly studied catfishes.

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Phenotypic plasticity in *Rana clamitans* existing in fish and invertebrate dominated predator communities

Larvae of anuran species occur at different points along a continuum of water permanency, ranging from small ephemeral ponds to permanent water sources. Predator communities vary also along the continuum and can be placed into two major categories, with fish communities and fishless or invertebrate dominated predator communities. In some cases, larvae of a particular anuran species may inhabit a wide range of pond types and co-occur with a wide range of predator communities. Some species may alter their behavior and others will undergo morphological changes in response to certain types of predators. *Rana clamitans* is a species that is known to successfully inhabit a wide range of pond types including those with and without fish. We studied *R. clamitans* at six ponds, three fishless and three with fish. We found that *R. clamitans* larvae in the fishless ponds had significantly more tail damage than in the fish ponds indicating unsuccessful attacks by invertebrate predators in the fishless ponds. At the same time we discovered that the size of the tadpoles at a given gosner stage was significantly larger in the fishless ponds and preliminary analysis indicate significant differences in body shape and performance. As discussed in previous findings, we suggest that these phenotypic differences are tradeoffs that may increase the fitness of individuals living in variable habitats.

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Reversible pathways in polyploid evolution in vertebrates

Comparative genomics has revealed possible ancient genome duplication events in vertebrates. Studies of recent occurrence of polyploidy will facilitate understanding the nature of genome duplication in vertebrate evolution. Processes of polyploid evolution have largely been recognized as irreversible, as hybrido- or gynogens are evolutionary dead-ends or bisexual tetraploids are infertile crossing with diploids. Examples in fish, however, indicate reversible pathways in polyploid evolution. Tetraploid *Cobitis striata* is an allotetraploid originated from hybrids between diploid *C. striata* and *C. biwaensis*. Existence of quadrivalents with homeologous crossing-over suggests evolution of tetrasomy from 2+2 paralogues (counter-diploidization). *Cobitis hankugensis-longicorpus*

complex is an all-female diploid-triploid hybrid complex which coexists with its parental bisexual diploid species. Experimental crosses revealed the diploid hybrid is a mother of the triploid hybrid which lays haploid ova. Crossing the haploid ova with one of the parental species regenerates normal diploids. Both parental species and hybrids share a common mtDNA haplotype indicating the diploid parental species actually regenerates in nature. Counter-diploidization and regeneration of diploids indicate that polyploid evolution is reversible at various stages, just as any other evolutionary processes which are diverging but reversible.

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Demography of a chytrid-infected population of one of the last Jambatos (*Atelopus*: Bufonidae) from Ecuador

Accumulated scientific and empirical evidence demonstrate that frogs of the genus *Atelopus* have suffered the most dramatic declines and extinctions in the neotropics. From, November, 2004 through December, 2005 we monitored a population of an undescribed species of *Atelopus* on the southeastern slopes of the Ecuadorian Andes. For 15 days each month we surveyed 12 transects of 100 x 2.5 m and 18 transects of 50 x 5 m, established on the shores of the stream and on the creek slopes, respectively. Individuals were photoidentified by their dorsal patterns, and we gathered data for sex, length, mass, activity, substrate, position in the transect, height above ground and distance to the river. Additionally, the presence of tadpoles was registered. Population dynamics were then correlated with environmental data: temperature, precipitation and relative humidity. On the shores we captured 181 individuals: 161 males, 19 females, 14 amplexant pairs and 1 juvenile; males showed strong site fidelity and their home range areas were calculated. Twenty five individuals (22 males and 3 females, or 13,81%) were found with clinical signs of chytrid infection. On the creek slopes we found 14 males, 13 females and 11 juveniles; these frogs were as far as 70m from the stream and did not exhibit any abnormal behavior. One hundred and twenty-three tadpoles were found adhered to gravel and boulders on runs and pools of the stream from June to November, 2005; 12.20% (n=15) showed varying degrees of depigmentation on tooth rows. Low population recruitment and high chytrid-related mortality is indicative of the critically endangered status of this population, requiring urgent conservation action.

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Chaetostoma (Siluriformes: Loricariidae), endemic and diverse: A new basal species from the highlands of Peru

With 43 valid described species, the genus *Chaetostoma* is one of the most diverse armored catfish genera. Forty-one species are distributed along the Pacific and Atlantic slopes of the Andes and two species on the slopes of the Guiana Shield. The extensive collections from Peruvian highlands at the Museo de Historia Natural of San Marcos University in Peru and the Academy of Natural Sciences in Philadelphia were studied. Nine valid described species were identified as distinct from each other based on the original descriptions and comparison with type material when available, and their distributions were plotted on maps. Four species from the Huallaga River basin were identified as new, increasing the number of species in this basin to five: two from Huánuco at 2000 m, and three from Tingo María at 600 m. Species within *Chaetostoma* are endemic to single drainage systems and restricted by elevation. The discovery of many species in sympatry suggests that there may be other undescribed species in areas where to date only single species are known to occur. The inclusion of one new *Chaetostoma* species on a preliminary phylogenetic analysis of the genus generated a single tree (CI=0.4189; RI=0.7245) based on 91 primarily osteological characters. This new species, from the headwaters of the Huallaga River (Huánuco), appears to be one of the most basal *Chaetostoma* species. The most strongly supported monophyletic group within *Chaetostoma* is based on two synapomorphies: the presence of a fleshy excrescence on the posterior tip of the supraoccipital and the low number (three to eight) of evertible cheek odontodes.

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Epidemiological risk of chytridiomycosis in amphibian communities of the Venezuelan Andes

Chytridiomycosis has been identified as one of the major forces driving population declines in amphibian montane species. However, *Batrachochytrium dendrobatidis*, the pathogenic fungus that causes this disease, is also known to persist endemically in some stable amphibian populations. What factors drive epidemic outbreaks of this disease is one of the most intriguing questions in amphibian declines. In the Venezuelan Andes, *B. dendrobatidis* was detected in three *Atelopus* species in 1988, just before their populations declined drastically. This pathogen persists today in bullfrogs (*Rana catesbeiana*) an invasive species recently introduced into this region. To evaluate the epidemiological risk that this disease represents to amphibian species endemic to the Venezuelan Andes, we conducted a survey to determine the geographic distribution of *B.*

dendrobatidis and its hosts, and estimated the prevalence and relative loads of infection in several species, using PCR assays. This pathogen was found in 13 species in an area of 62 km². The high prevalence and loads of the pathogen in *R. catesbeiana* suggests that this exotic species is the most important reservoir, although its distribution is still restricted to a small area. Among the native frogs, *Hyla meridensis*, a species endemic to this region with the greatest habitat overlap with bullfrogs, showed the highest prevalence. Epidemiological implications are discussed in light of the potential dispersal of bullfrogs, an invasive species known to host this pathogen asymptotically.

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Ontogenetic shifts in respiratory abilities of common mudskipper
(*Periophthalmus kalolo*)

Mudskippers (family Gobiidae) are tropical, amphibious fishes capable of utilizing both air and water as a respiratory medium. Common mudskipper, *Periophthalmus kalolo*, inhabits mangal environments on Hoga Island, southeast Suluwesi, Indonesia. Although little is known about mudskipper life history, juveniles are thought to be more dependent on mangal tidepools than adults; presumably because post metamorphose juveniles are less effective at extracting oxygen from air. Empirical data, however, are lacking. We compared oxygen uptake of adult and juvenile *P. kalolo* in water and air to assess the potential respiratory basis for habitat partitioning in Hoga mangals. Aquatic and aerial respiration were examined using flow-through and manometric respirometry. Respective mass corrected oxygen uptake values for adults (≥ 1.8 cm) and juveniles (≤ 1.7 cm) were $0.332 (\pm 0.124)$ and $0.344 (\pm 0.186)$ mg/g/h in aquatic trials and $0.366 (\pm 0.196)$ and $1.849 (\pm 0.811)$ mg/g/h in aerial trials. While values were statistically indistinguishable between life stages in water and within adults between media (ANOVA; $p \geq 0.687$), juvenile aerial oxygen uptake was significantly higher than adult values (ANOVA; $p \leq 0.001$). Juvenile air to water uptake expressed as a ratio show four times higher oxygen air to water ratios measured in adults. Our values suggest that tidepool dependence of juvenile common mudskippers is not due to limitations in their ability to utilize oxygen from either medium, but more likely is related to attributes such as predation, dessication or the need to enter pools to excrete ammonia. Ontogenetic shifts in aquatic and aerial oxygen extraction abilities allow common mudskipper to partition their habitat and reduce cannibalism.

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Intraspecific phylogeography of elassomatidae: A test of the interglacial refugia hypothesis

Current understanding of freshwater phylogeography in North America has been largely restricted to studies of highland regions and constituent fauna. This study aims to detect and describe intraspecific diversity within sympatric lowland species (*Elassoma*) and compare patterns of variation associated with biogeographic boundaries. The physiography of the Coastal Plain provides a unique opportunity for phylogeographic investigations of freshwater organisms. Processes involving Neogene sea-level dynamics have been shown to strongly

influence patterns of community evolution and speciation. The lowland fish fauna of eastern North America consists of multiple areas of endemism separated by historically inundated areas formed during the Eemian interglacial period. Clades within interglacial refugia should be more closely related to each other than to clades occurring in historically inundated areas. Physiographic features such as the Fall Line, Cody Escarpment, and Lake Wales Ridge provide a spatial template upon which comparative analyses of intraspecific variation can be imposed. These physiographic features are each associated with a biogeographic boundary and hypothesized interglacial refugia. Morphometric variables (18), meristic variables (21), and mtDNA sequence variation are determined for sympatric species of *Elassoma*. Refugia populations that predate the last interglacial seastand should be ancestral to those found within previously inundated areas.

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Feeding habits of the hammerhead sharks *Sphyrna zygaena* and *Sphyrna lewini* in Ecuador

Feeding habits in Ecuadorian waters of 156 specimens of smooth hammerhead shark *Sphyrna zygaena* (Linnaeus, 1758) and 91 specimens of scalloped hammerhead shark *Sphyrna lewini* (Griffith & Smith, 1834) were studied. The specimens were obtained from Ecuadorian small-scale fishing during 2003 at Manta, Ecuador. Of the smooth hammerhead stomachs examined, 143 contained food (92.3%), and 13 were empty (7.7%). This species fed on cephalopods, crustaceans, and fish, and using the index of relative importance (IRI), it was shown that *S. zygaena* has a preference for cephalopods such as: *Dosidicus gigas* (84.6%), *Sthenoteuthis oualaniensis* (6.7%), and *Ancistrocheirus lesueurii* (5.1%). Males and females of *S. zygaena* had similar diet and trophic overlap. Diet variation by size in this shark was not significant. The trophic niche width was narrow, so *Sphyrna zygaena* is a specialist predator, whereas of the scalloped hammerhead specimens, 82 (90.1%) had food or partially digested remains in their stomachs, and 9 (9.9%) had empty stomachs. Of the prey species found, 39 were identified. The IRI index showed the most important prey were cephalopods: *Dosidicus gigas* (43%), *Mastigoteuthsi dentata* (11.9%), and *Ancistrocheirus lesueurii* (11%). *S. lewini* is a specialist predator that fed mainly during the night in the oceanic area. We found differences in diet between males and females, and variations in diet by size.

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Evolution of physiological changes in association with aposematism in poison frogs (Dendrobatidae)

Aposematism is defined as the nonrandom association of conspicuous coloration and noxious substances in a single organism. Several possible adaptations are thought to promote the evolution of aposematism. These include novel biochemical pathways for toxin acquisition, specialized feeding behavior, and metabolic adaptations. Pough and Taigen (1983) were the first to suggest the association between aposematism, diet specialization, and higher aerobic capacity in poison frogs. However, their analysis included only four taxa and did not take into account shared ancestry. Cryptic species were presumed to have low aerobic capacities, generalist diets and no skin alkaloids. We have extended such analyses to 36 species of across the poison frog family. By using a phylogenetic context, we have found a significant association between aposematism and higher aerobic capacity in poison frogs. This positive correlation supports the idea that physiological adaptations are a key evolutionary step between the sequestration of dietary alkaloids and the evolution of warning coloration.

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Oribatid mites: A major dietary source for alkaloids in poison frogs

Brightly colored poison frogs contain an alkaloid-based chemical defense that is dependent on a natural diet of alkaloid-containing arthropods. More than 800 individual alkaloids (organized into 24 different structural classes) have been documented in poison frogs. Identifying the specific arthropod sources responsible for this alkaloid diversity is necessary to understand the ecology and evolution of chemical defense. At present, certain species of ants, beetles, and millipedes represent the only known sources for poison frog alkaloids. The majority of alkaloids appear to be derived from ants, suggesting that ants play a significant role in chemical defense among poison frogs. In this study, I report the presence of tricyclic, indolizidine, quinolizidine, spiropyrrolizidine, and pumiliotoxin alkaloids in several species of oribatid mites. I also present data on the presence of these alkaloids in the microsympatric dendrobatid frog, *Dendrobates pumilio*, from locations in Costa Rica and Panama. In addition, I will also present quantitative data on diet for *D. pumilio* from these same locations, demonstrating that these species of mites are consumed regularly as part of the natural diet of these frogs. Although ants remain an important source for poison

frog chemical defense, these findings suggest that oribatid mites now represent a new and significant source for alkaloids in poison frogs.

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Effects of food availability on RNA, DNA, and growth of naked goby, *Gobiosoma bosc*

We evaluated RNA, DNA, RNA:DNA ratios, and somatic growth of naked goby, *Gobiosoma bosc*, as measures of condition related to larval feeding conditions. Eggs were collected in the field using PVC pipe nest-traps, and were hatched in the lab, yielding cohorts of larvae that were randomly assigned to three feeding treatments in two replicate tanks per treatment. Goby larvae were fed rotifers, *Brachionus plicatilis*, at densities of 20, 200, or 1200 per liter (low, medium, and high, respectively). Prey densities were measured every eight hours and adjusted accordingly. The experiment consisted of two trials of 10 and 8 days duration, respectively. A total of 699 larvae were sampled, with one to five individuals per tank sampled daily for nucleic acid analysis. An additional one to four individuals per tank were sampled daily for length-weight measurements. Wild *G. bosc* larvae were collected using a light trap and analyzed as a direct comparison of growth and nucleic acid concentrations to lab-reared fish. Preliminary lab results indicated a declining trend for growth in length with decreasing prey densities over time. Both DNA and RNA concentrations differed significantly between all treatments (ANCOVA, $p < 0.0001$), and showed declining trends with decreasing prey density over time. Mean RNA:DNA ratios showed significant treatment effects indicating declining trends with increasing food treatment (ANCOVA, $p = 0.0411$). We are evaluating potential interactions and trade-offs within treatments, including: daily otolith growth; total, natural, and fishing (sampling) mortality; convergence of rations; and the distribution of RNA:DNA ratios.

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Effects of haying and agricultural practices on the wood turtle, *Glyptemys insculpta*

The impact of agricultural practices on a population of wood turtles (*Glyptemys insculpta*) in southern Quebec, Canada was investigated. Of 30 turtles followed via radio-telemetry, 20% died as a result of agricultural activities. Annual survivorship (S) of adults was 0.904 and 0.868 and for juveniles it was 0.815 and 0.831 for 1998 and 1999, respectively. Among adults, survivorship of males and females did not differ. Of those turtles that survived, many had injuries inflicted by disc mowers and tedders. Adult mutilation rates were $90\% \pm 3\%$ in both years; whereas, the maximum frequency reported for juveniles was 57%. A Carapace Mutilation Index (CMI) was derived in order to quantify the distribution and severity of injuries. CMI values for males, females, and juveniles were 0.20, 0.14, and 0.07, respectively. Only male and juvenile CMI differed significantly. Adults had significantly more carapace injuries and limb amputations on their right sides. This bilateral asymmetry of injuries most likely resulted from a combination of turtle flight behavior, hayfield-river orientation, mower type, and harvesting practices. We reiterate the recommendations of forage researchers: setting the cutting height of disc mowers to 100 mm (4 inches) increases harvest yields, reduces wear on machinery, and decreases soil erosion. A by-product of such a change in cutting height is that turtle mortality and injury rates also should be reduced, as wood turtle carapace height is < 87 mm. Without changes in agricultural practices, this population will be extirpated.

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Cardiac response to bufonid prey in *Rhabdophis tigrinus* (Colubridae), a snake that sequesters dietary toxins

Animals that sequester dietary toxins for their own defense must be resistant to the normal physiological effects of those compounds. The Asian naticine snake *Rhabdophis tigrinus* sequesters steroid toxins from toads that have been consumed as prey, delivering the toxins through specialized integumentary structures known as nuchal glands. In most predators, including snakes that do not normally consume bufonid anurans, the bufadienolide steroids of toads exert a powerful, and sometimes lethal, cardiotoxic effect. To determine the effect of ingested toads on cardiac function in *R. tigrinus* we monitored four snakes by electrocardiography following force-feeding with *Bufo japonicus*. A single individual of *Elaphe quadrivirgata*, which normally preys on nonbufonid anurans, also was force-fed *Bufo* for comparative purposes, and both *Rhabdophis* and

Elaphe were force-fed *Rana* as a control. All snakes survived force-feeding of *Rana*. Although ingestion of *Bufo* rapidly led to death in *Elaphe*, all individuals of *Rhabdophis* survived the ingestion of toads, with little effect on electrocardiographic parameters. Previous studies have demonstrated that several other natricine species are resistant to the effects of ingested toads, as well as other toxic prey such as newts. These data suggest that generalized resistance to bufadienolides preceded and facilitated the evolution of toxin sequestration in *Rhabdophis*.

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Reproductive biology of species of *Bathyraja* (Chondrichthyes, Rajidae) on the Argentinean continental shelf

Skates have become the sixth most economically important fish resource (over a total of 46 commercial fish species) landed by commercial bottom-trawlers in Argentina. Biological data of skates (especially on reproduction) are needed to improve management of their fisheries. Despite the abundance and diversity of *Bathyraja* genus in Argentinean waters (eight species), very little is known about its basic biology and ecology. Specimens of *Bathyraja brachyurops* (n=383), *B. macloviana* (n=360), *B. albomaculata* (n=229), *B. magellanica* (n=120), *B. griseocauda* (n=88), *B. multispinis* (n=29), *B. cousseauae* (n=26) and *B. scaphiops* (n=16) were collected from research cruises carried out by the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP, Argentina) since 2003. Study area extended along Argentinean continental shelf between 36°S and 55°S. Size at maturity of the four most abundant species was assessed from the allometric growth pattern of uteri, oviducal glands and clasper with respect to total length (L_T). The length at which 50% of the skates were sexually mature (L_{T50}) was estimated from a logistic ogive fitted to the data using maximum-likelihood approach. Females of *B. brachyurops* and *B. macloviana* matured at a larger size than males, while both sexes of the other two species appeared to attain sexual maturity at about the same L_T . L_{T50} in both sexes of the four species was achieved at >75% of the maximum L_T observed. Females carrying egg cases in their uteri (in different egg case formation stage) were found, and the date and geographic position of these females were recorded to identify egg-laying seasons and areas. Furthermore, egg cases were removed and preserved in order to describe them. Other reproductive characteristics of these species are being analysed. These

preliminary results are part of an ongoing study about biology, ecology and biodiversity of species of *Bathyraja* on the Argentinean continental shelf.

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Acoustic differences between tree and mating calls in pine woods treefrogs (*Hyla femoralis*)

Anurans have four basic calls: advertisement, reciprocation, release, and distress calls. Advertisement calls often are termed mating calls, which have been intensively studied since the pioneering review by W. Frank Blair in 1958. However, male treefrogs also emit a diurnal tree call from the tops of trees during the breeding season. As dusk approaches, tree calls continue from lower in the trees, and if conditions are favorable, males jump to the ground and travel to a nearby breeding pond where they begin their repetitive mating calls. The function of tree calls remains unknown. By calling from treetops several hours before mating begins, males may attract either more females or more distant females, and also could deter other males from the area. We predicted that because tree calls and mating calls are broadcast at different times and may serve different functions, they may be acoustically different. We recorded tree calls and mating calls of the pine woods treefrog (*Hyla femoralis*) in Seminole County, Florida, U.S.A. We found few similarities between these two calls. While both calls are broadcast at similar frequencies (between 1500 and 5000 Hz), call duration and number of pulses varies. Tree calls are shorter, have fewer pulses, and more time between pulses compared to mating calls. In contrast, Blair noted that tree calls of *H. squirella* lacked a harmonic component, which increases in frequency in a mating call. To the best of our knowledge, our acoustical analysis of the tree call of *H. femoralis* is the first since Blair's 1958 sonogram of the tree call of *H. squirella*.

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Reproductive barriers among species in the *Fundulus notatus* species complex

We examined the strength of several pre and post-zygotic reproductive barriers among species in the *Fundulus notatus* species complex. Fishes in this complex are found throughout the Midwestern and Southern United States. The two most widely distributed members of this complex, *F. notatus* and *F. olivaceus*, occur throughout much of the Mississippi River drainage as well as the coastal drainages of the Gulf of Mexico. *Fundulus euryzonus* are more narrowly distributed and endemic to the Pontchartrain drainage in Louisiana and Mississippi. All members of the complex have similar ecologies, and encounter one another in numerous contact zones throughout their ranges. There are numerous reports of hybrid individuals from contact zones, typically in low abundance. It is not known if this low abundance is due to prezygotic (eg. assortative mating) or postzygotic (eg. endogenous or exogenous selection against hybrids) barriers. The purpose of this study was to assess the strength of some of these barriers through mate selection (non-choice mating trials) and hatching success trials involving first and second generation hybrids in the *Fundulus notatus* complex.

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Overview of the Lithogeninae and a new species from southern Venezuela

The systematics of the loricariid subfamily Lithogeninae is reviewed. A third species was discovered from a single locality in the upper Orinoco River drainage of southern Venezuela and is the only lithogenine known from more than a handful of specimens. The new species shares with its congeners the trunk dermal plates reduced to three paired series, a bifurcate levator arcus palatini crest, expanded hyomandibula lateral lamina, and palatine sesamoid not reaching the nasal capsule, thus confirming its placement in *Lithogenes*. The new species is diagnosed among congeners by absence of odontodes on the proximal portion of ventral surface of the first pelvic-fin ray (vs. ventral pad covered with embedded odontodes along entire length); accessory premaxillary teeth absent; anal fin with intense pigment band along base and diffuse spot at midlength of

fin rays (vs. pigment band at base absent, fin rays dusky, without distinct spot). Features of musculoskeletal anatomy hitherto unknown for lithogenines are presented, along with aspects of sexual dimorphism, and the anatomy of the reproductive and digestive systems that are unique or unusual among loricariid catfishes. Lithogenine loricariids share a number of unique features with astroblepid catfishes that are not observed to occur in other members of the Loricariidae, such as pelvic-fin morphology, pelvic musculature, and associated adaptations for climbing. Evaluated against the evidence supporting their phylogenetic placement as the sister-group to all other Loricariidae, exclusive of the Astroblepidae, these shared similarities suggest that the association with rocky habitats of headwater-stream systems and the ability to climb vertical surfaces may represent ancestral conditions for the lineage leading to the astroblepid plus loricariid catfishes.

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Chelonian illustration: The legacy of Schoepff's *Testudo terrapin*

Scientific illustration is an often neglected, but vital component of zoological investigation. It has evolved through a complex development of styles and techniques from cave art to modern photography. Originally appearing in paper form on hand-executed eleventh century manuscripts, most early images were exaggerated, seeking appeal with unrealistic stylized designs, sacrificing accuracy for socio-religious conformity. Organism's images were generally based on descriptions or legends. The resulting depictions bear witness, giving credence to inaccuracies, and myths. Early printed images engraved on wood, evolved to the steel or copper plates of Schoepff's *Testudo terrapin* (1792-1801), Shaw's *Testudo concentra* (1802) and Boulenger's *Malacoclemmys terrapin* (1889). Later examples [Latreille's *Testudo centrata* (1801), Holbrook's *Emys terrapin* (1842) and Wied's *Emys pileata* (1865)] illustrate the scientific method's influence paired with hand-colored realism. During this time, works written for public appeal increased and common animals such as *Malaclemys* were seen in a new light. Although images had been copied from earlier works since the 1600's, the practice became more rampant during this time with accuracy and detail decreasing dramatically. During the late 1800's, chromolithography, the first true color printing, was utilized widely, later augmented with labor saving photography in Hay (1905). Fewer illustrations were drawn from this time on due to the this, yet hand-drawn images remain an important documentation tool. More easily reproducible than photographs, they have a life to them, an embodiment and viewpoint of the artist. Images also serve as type specimens (neotypes), the case with Gray's *Chitra indica*, and Schoepf's *Malaclemys* (*Testudo terrapin*).

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**Morphometric variation of mountain catfishes (Amphiliidae, *Amphilius*) in
Guinea, West Africa**

Geometric morphometric techniques were used to examine intra- and interspecific variation among Guinean amphiliid catfishes. Specimens identified as three amphiliid catfish species, *Amphilius platychir*, *A. rheophilus*, and *A. kakrimensis*, were collected in streams of the Fouta Djallon highlands and Zone Forestiere of Guinea, West Africa in 2002 and 2003. Principal components analyses of lateral body profiles and ventral images of the head, recognizing 15 and 9 landmarks, respectively, allows clear separation of two morphotypes. Specimens identified as *Amphilius platychir* display a deeper body as well as a more pronounced notch in the branchial membrane than those identified as *A. rheophilus*. Specimens of *A. kakrimensis* are similar in ventral head morphotype to *A. platychir*. Variation in depth of the branchial membrane notch is also observed among specimens of *A. rheophilus*.

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**A GIS-based examination of niche evolution in horned lizards
(*Phrynosoma*)**

Recent developments in biodiversity informatics have promoted new uses for museum specimen data to investigate factors influencing broad-scale ecological and evolutionary patterns. For example, the fundamental ecological niche of a species can be characterized by analyzing the association between species occurrence data and broad-scale environmental variables contained in geographic information systems (GIS) datasets. In this study, I applied a GIS-based approach to examine the evolution of the fundamental niche of horned lizards (*Phrynosoma*). Species in the genus *Phrynosoma*, which are distinguished by their flat body plan, cryptic coloration, and unique horn morphologies, occur from Canada to southern Mexico in habitats ranging from sparsely-vegetated lowland deserts to mountainous forests. I used species occurrence data in conjunction with 20 GIS environmental variables to characterize the niche of extant species of *Phrynosoma*. Using these results, I calculated niche overlap among species pairs and assessed the relationship between niche overlap and species relatedness in a phylogenetic context. Results suggest that niche overlap and phylogenetic similarity are not correlated and that niches are not

consistently conserved among closely related species. This study offers an example of how biodiversity informatics can be applied to better understand evolutionary patterns and factors regulating broad-scale patterns of biodiversity. The integration of measures of phylogenetic relationships with species occurrence data offers a relatively new approach to the study of the niche in this group of morphologically and ecologically similar lizards, and may provide a framework for studying other groups. Furthermore, identification of the key environmental attributes that characterize species occurrences has conservation implications for protection of threatened species, such as the Texas horned lizard (*Phrynosoma cornutum*).

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The 'pseudo-craniovertebral articulation' in the deep sea fish *Stomias boa*
(Teleostei: Stomiidae)

Many predatory deep sea fishes show adaptations in the feeding apparatus, e.g. an enormous gape, the acquisition of long daggerlike teeth and a very distensible stomach, to be capable of swallowing very large prey. These traits can be well observed in members of the orders Saccopharyngiformes or Stomiiformes. In the stomiiform genera *Malacosteus* and *Chauliodus* a profound modification of the anterior vertebral column has long been known, allowing for extreme movements of the head during prey capture and swallowing. The present study gives a detailed morphological description of the stomiiform deep sea fish *Stomias boa* based on dissection, serial sections and clearing and double staining methods. In this genus the first two vertebrae are reduced. Instead of these in this region the notochord persists allowing extreme upward bending of the skull. To both sides of the notochord there exist large pads made of dense connective tissue. These pads, spanning from the first enlarged neural arches to the chordal sheath, embrace the protruding exoccipitals thus constituting a kind of double ball- and socket joints for the head. This 'pseudo-craniovertebral articulation' is considered as functional substitute for the reduced two vertebrae. By the action of the strong epaxial musculature the skull can thus be extremely raised upwards further expanding the gape, which already is strongly expanded by the elongated lower and upper jaw bones. As a consequence of these adaptations most other parts of the skull are accordingly modified. The skull is compressed, the gills are relocated to the underside of the mouth and the modified hypaxial musculature participates in mouth closure.

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Species assemblages, distribution, and abundance of serranids in the
South Atlantic Bight, 1973-2004

Spatial and temporal trends of serranids in the South Atlantic Bight (SAB) were analyzed from the 30+ year data set of a fishery-independent catch survey. Serranid catches in a bottom trawl (1973-1980) were dominated by sand perch, *Diplectrum formosum*; black sea bass, *Centropristis striata*; and bank sea bass, *Centropristis ocyurus*. *Diplectrum formosum* was found most often between 21-40 m, *C. striata* was found at 21-30 m, and *C. ocyurus* was found predominantly at 31-80 m. Trap catches (1988-2004) were dominated by *D. formosum*, *C. striata*, *C. ocyurus*, *Mycteroperca phenax* (scamp), and *Epinephelus morio* (red grouper). In trap catches, *D. formosum* was found most often at 31-40 m, *C. striata* at 21-30 m, *C.*

ocyurus at 21-40 m, *E. morio* at 31-40 m, and *M. phenax* at 41-80 m. Overall, fishes were found in high densities near Onslow Bay, North Carolina, on reefs off the coast of central South Carolina, and near Cape Canaveral, Florida. Catches of red grouper, black sea bass, and sand perch were low in the early 1990s followed by increased catches later on, while bank sea bass catches showed the opposite trend. Only red grouper showed a relationship between trap catches and fishery landings from the previous or following year. Cluster analyses showed that *D. formosum*, *C. striata*, and *C. ocyurus* occurred in trawls together, as did *Serranus phoebe* and *Serranus notospilus*. *Diplectrum formosum*, *C. striata*, and *C. ocyurus* were also found together in trap catches, as were *M. phenax*, *Mycteroperca microlepis* (gag grouper), and *E. morio*, as well as *Epinephelus drummondhayi* (speckled hind) and *Epinephelus niveatus* (snowy grouper). Results of this study indicate locations of high abundance for several commercial species; this information should be taken into account in future fishery management decisions.

***SCHÖNHUTH, SUSANA; DOADRIO, IGNACIO; MAYDEN, RICHARD L.**

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Speciation in the North American genus *Dionda* (Actinopterygii, Cyprinidae) (II)

Most recognized species of the genus *Dionda* inhabit drainages of the Gulf of Mexico from central Mexico to southern United States, and were considered a monophyletic group based in morphology, osteology, and allozyme studies. A molecular phylogeny of species of *Dionda* was used to reconstruct their relationships and to infer biogeographic hypotheses based on one mitochondrial (Cyt-b) and three nuclear genes (S7, Rhodopsin, Rag1). The 14 species of *Dionda* analyzed were never recovered as a monophyletic group when species from other related genera were included in the phylogeny. One well-supported clade is formed by northern species of the current genus *Dionda*. All these species inhabit present or past tributaries of the Rio Grande basin from northern Mexico and southern USA. In this analysis the other group of species included in *Dionda* includes the Southern species of the genus plus *Codoma ornata*. One highly divergent undescribed species of *Dionda* is sister to this clade. All these species of the Southern '*Dionda*' clade inhabit headwaters of the Panuco-Tamesi drainage and coastal Nautla River and are closely related to the putative monotypic genus *Codoma*. This clade is the sister group to Mexican species of the genus *Cyprinella*, and is proposed as a genus endemic to Mexico.

***SCHRIEVER, TIFFANY; FONTENOT, CLIFFORD L. JR.; CROTHER, BRIAN I.**

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Effects of salinity on tadpoles of the green treefrog (*Hyla cinerea*) across local habitats

Saltwater intrusion is among one of the highly detrimental factors contributing to wetland loss in the Lake Pontchartrain area in southeast Louisiana. Studies have documented salinity effects on plant communities in southeastern Louisiana, but none has dealt with its effect on the anuran community. Salinity increases can have profound effects on the reproductive success of amphibians as well as the fitness of their progeny. However, the effect of salinity is unknown for any amphibian in this area. This study investigates the effects of various salinity levels on mortality, larval growth, and metamorphosis on one of the most abundant frogs (*Hyla cinerea*) in the Manchac swamp area. The Manchac Wildlife Management Area (MWMA) is located in the Lake Pontchartrain basin in southeastern Louisiana. Salinity tolerance was determined using four clutches of eggs, two from intermediate salinity marshland sites and two from freshwater sites during different ontogenetic stages in a common garden experiment. For each clutch 20 tadpoles were reared in each of six salinity levels (2, 4, 6, 8, 10, and 12 parts per thousand) and a freshwater control. Preliminary data indicate that water salinity has a distinct effect on embryonic mortality. Salinity effect varied among populations and developmental stages. Salinity stress during the late larval stages (25–46) showed substantial influence on developmental rate. My data indicate that mean developmental time is longer than currently noted in literature, possibly due to salinity stress. In addition, weight and SVL are strongly linked and show similar trends among populations at metamorphosis.

SCHULTZ, ERIC T.

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Sexual selection on birth date, birth age, and brood sex ratio in a live-bearing fish

Natural variability in breeding time provides an opportunity to examine the selective pressures that affect phenology. Prior research has revealed that breeding time is subject to selective conflicts between the energetic needs of adults and offspring, and between different seasons such as early-summer and overwinter survival. Less well appreciated is the conflict that can arise between male and female offspring such as when the mating success of males is affected by their birth or hatch date. Male dwarf surfperch (*Micrometrus minimus*) are mature at birth and they promptly inseminate newborn females. Under such

conditions, male birth date affects mating success, which is also a function of female availability and the intensity of intrasexual competition for mates. I employed a game-theory model to predict the optimal distribution of male birth dates relative to female birth dates. Males are predicted to have an earlier average birth date than females. Observations of a dwarf surfperch population revealed that male birth dates were in fact shifted several days earlier than female birth dates. There were two causes of the sexual difference: males are born after fewer days *in utero*, and early-season broods are male-biased. A good empirical fit to predictions indicated that the selective pressures have been well characterized in the model.

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Diets of the alien snapper *Lutjanus kasmira* and native goatfishes in Hawai'i

The snapper *Lutjanus kasmira* (Family: Lutjanidae) was introduced to Hawai'i during the 1950's with the goal of enhancing commercial and recreational fishing opportunities. Although the species spread quickly throughout the archipelago and is abundant across a substantial depth range, it is not sought after as a food fish. Also, there is a widespread perception among the general public that *L. kasmira* is adversely affecting native species by preying on them or by competing with them for limited resources. No scientific evidence exists to support or refute these contentions, however. To address these concerns, we studied various aspects of the ecology of *L. kasmira* in relation to some key native fishery species. The present study focuses on dietary analysis of gut contents of *L. kasmira* and three native species of goatfish (Family: Mullidae): *Parupeneus multifasciatus*, *Mulloidichthys vanicolensis*, and *Mulloidichthys flavolineatus*. These fishes were selected as focal species in the study because prior studies indicated that they were ecologically similar to *L. kasmira* and thus might be among the species most likely to compete with it for food resources. Diets of *P. multifasciatus* were most similar to *L. kasmira*, in spite of the fact that our data indicate that these species feed at different times of day. Diets of the two *Mulloidichthys* species were most similar to each other; there is some indication that the diet of *M. vanicolensis* may be more similar than the diet of *M. flavolineatus* to the diets of *P. multifasciatus* and *L. kasmira*. Although it has been suggested that *L. kasmira* preys on native fish or crustacean resource species, neither suggestion was supported by our data. Ultimately, the results of this study do not provide convincing evidence of strong adverse effects on native fishery species through predation or competition for food.

***SCHWALBE, CECIL R.; SIGAFUS, BRENT H., SUHRE, DENNIS O., STANNARD, AARON**

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Population sizes of desert-breeding anurans

Determining population sizes of desert anurans is especially difficult because of the brief, erratic timing of standing water; the extremely rapid decline in numbers of adults at breeding sites following breeding events (sometimes orders of magnitude in 24 hours, if no rain the second night); and high numbers of species (up to seven at some sites). We computed Lincoln-Petersen population size estimates of breeding aggregations of desert toads and spadefoots by collecting, marking, and releasing all anurans we could capture at a site; waiting at least an hour for anurans to commence calling and breeding again; then duplicating the collecting effort again to provide the two equal-effort sampling periods required for that estimator. On most nights, we could evaluate two ponds. We estimated as many as nine populations of five species at two sites in a single night (*Bufo alvarius*, *B. cognatus*, *B. punctatus*, *Scaphiopus couchii*, *Spea multiplicata*). Species aggregations sampled ranged from single-species populations of *S. couchii* or *B. cognatus* to five-species aggregations, with total aggregation estimates ranging from eight *B. cognatus* to 2937 individuals of five species. For large, multi-species aggregations, only rarer species were weighed, measured, marked and released; abundant species (more than 200 individuals) were just sexed, counted, and released, and recapture frequencies for the second sampling period estimated as the mean of all previous recapture frequencies for those species. Males appeared to meet the closure requirement better than females, who often were still arriving during the second sampling period; a third sampling at a given pond, delayed to allow females more time to arrive, would allow better quantitation of females. Handling the anurans during the first sampling period does not seem to discourage breeding, and may enhance it. This method has broad applicability for estimating population sizes of explosive breeding amphibians in many biomes.

***SCOTT, DAVID E.; METTS, BRIAN S.; GIBBONS, J. WHITFIELD**

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Enhancing amphibian biodiversity on golf courses through use of seasonal wetlands

Ecologists generally recognize the value of seasonal wetlands, but these wetlands are often ignored in landscape management decisions and practices, including golf course design. We sampled the amphibians and reptiles that use wetland habitats on five golf courses for three years in the sandhills of South Carolina and Georgia, and compared these survey data to concurrent surveys at 11 nearby (off-course) seasonal wetlands. Two of the courses sampled had on-course seasonal wetlands, which allowed us to compare amphibian diversity on these courses to the other three courses that did not have seasonal wetlands. Permanent wetlands were more numerous than seasonal wetlands on the golf courses we sampled. However, greater amphibian species richness occurred at both off-course and on-course seasonal wetlands compared to golf course permanent lakes and ponds: 24 species were sampled at comparison seasonal wetlands, 18 species at the two courses with seasonal wetlands plus permanent aquatic habitats, and 11 species at the three courses with only permanent water. The permanent golf course wetlands harbored numerous fish species, and these wetlands contained only the few amphibian species that can tolerate fish. Much of the difference between the species lists for golf courses with and without seasonal wetlands results from the presence of amphibian species that prefer fish-free wetlands on the courses that have seasonal wetlands, such as *Ambystoma opacum* (marbled salamander), *Ambystoma maculatum* (spotted salamander), and *Gastrophryne carolinensis* (eastern narrow-mouthed toad). These results demonstrate that the incorporation of seasonal wetlands into the design of the golf-course landscape would likely enhance amphibian biodiversity.

***SCOTT, DAVID; CROSHAW, DEAN; KOMOROSKI, MARK**

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Terrestrial distribution of salamanders around an isolated wetland

Terrestrial habitats surrounding isolated wetlands are a critical resource for many pond-breeding amphibian species, yet few studies have examined the terrestrial distribution of post-metamorphic juveniles and adults. We used an encircling drift fence at a breeding pond in conjunction with partial fences at 90, 172, and 332 m from the wetland to estimate the distribution of adult marbled salamanders (*Ambystoma opacum*; 3 years) and mole salamanders (*A. talpoideum*; 1 year), as well the habitat use of juvenile *A. opacum* (1 year). In general the form of the distribution of animals was one of exponential decay, and not a normal

distribution as has been reported previously. For juvenile *A. opacum*, 80% of newly metamorphosed animals dispersed to Zone 1 (10-89 m from the wetland boundary), 10% to Zone 2 (90-171 m), 6% to Zone 3 (172-331 m), and 4% to Zone 4 (beyond 332 m). Distribution of adult *A. opacum* varied among years, but an average of 27% (range 21-32%) occurred in Zone 3 or beyond in all years. Forty percent of adult *A. talpoideum* occurred in Zone 1, with 15%, 25%, and 20% distributed in Zones 2-4, respectively. Knowledge of the shape of the terrestrial distribution function is important due the strong influence it has on the buffer zone area required to capture 50% or 95% of the population. Our results indicate that, compared to a normal distribution, a distribution that mimics exponential decay may require a smaller area to protect 50% of the populations of these two ambystomatid salamander species, but a larger area would be needed to protect 95%.

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Conservation of terrestrial habitat for California tiger salamanders (*Ambystoma californiense*)

California tiger salamanders (*Ambystoma californiense*) have recently been placed on the list of federally endangered species, thus increasing interest in how reserves should be designed in order to protect them. Our study uses an array of pitfall traps in order to capture *A. californiense* at varying distances from a vernal pool in which they breed. The density of adult salamanders decreases exponentially as a function of distance from the pool, while the density of juveniles peaks at 100-300 meters from the pool before decreasing exponentially. These empirical density observations are compared with a mechanistic model predicting salamander distribution based on intraspecific competition. They are also combined with information on age-specific survivorship and fecundity of *A. californiense* generated by Trenham et al. (2000) to create a model that calculates the value of land at varying distances from the vernal pools in maintaining the *A. californiense* population. Capture data has also been combined with a number of GIS layers in order to determine *A. californiense* habitat preference based on a number of factors, such as density of gopher burrows, elevation, and proximity to old eucalyptus stands. Finally, *A. californiense* individually identifiable by PIT tags or digital photographs enable us to examine the directionality of *A. californiense* migrations to and from breeding ponds as both juveniles and adults. All of this information will be useful in planning reserves and for assigning mitigation costs when land near breeding ponds is disturbed.

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Alien vs. predator, energetics of the Everglades pythons

A breeding population of Burmese pythons is now established in the Everglades National Park. Hatchlings to 4.3-m adults have been captured in the park, mostly along major roads. Gut contents reveal that the Everglades pythons are feeding relatively frequently, chiefly on rodents and birds. In September 2005, an adult python was found dead after it had consumed a 2-m alligator. It is hypothesized that the python had eaten the alligator and then die due to complications stemming from digesting the alligator or from an encounter with another predator. Curious on whether Burmese pythons can digest alligators, we fed alligators to Burmese pythons and tracked gastric digestion of alligators by X-ray while measuring their metabolic rates. Elements of the alligator skull were still evident at 3 days postfeeding, with the last of the skeleton dissolved by day 9 of digestion. While digesting alligators, pythons experienced 8-fold increase in metabolic rate and maintained elevated rates of metabolism for 9 days. Using metabolic measurements taken during the digestion of rats and alligators, growth efficiencies from these meals, and assumptions of daily energy expenditures, we have modeled the growth and food consumption of the Everglades Burmese pythons. From hatchling, Burmese pythons in the Everglades could theoretically reach adulthood in four years. During that time an individual could consume 100 kg of food by feeding on 40 to 150 different prey items ranging from small rodents (deer mice, cotton rats) to large mammals (opossum, bobcat), birds (egret, ibis), and alligators.

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Long-term changes in snake populations at the Kennedy Space Center, Florida, 1977-2006

The Kennedy Space Center represents one of the largest areas of undeveloped habitat on the east coast of Florida. Starting in 1977, we began monitoring the numbers of snakes found along a standardized road transect, and continued that monitoring from 1977-1979 and from 1992-2006. Previous reports (through 2000) indicated a significant decrease over time in both total numbers of snakes and species richness, especially for two aquatic species (green water snakes and cottonmouths). Data from 2001-2006 showed a significant increase in numbers of snakes, presumably as populations recovered from a long-term drought in the late 1990s. Although there has been a recent increase in species diversity, neither green water snakes nor cottonmouths have recovered anything close to their

former numbers. The reasons for these changes, as well as the impacts of road mortality will be discussed.

***SELMAN, WILL; QUALLS, CARL**

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The impacts of Hurricane Katrina on a population of yellow-blotched sawback turtles (*Graptemys flavimaculata*) in the lower Pascagoula River

The yellow-blotched sawback turtle (*Graptemys flavimaculata*) is a freshwater aquatic turtle that is endemic to the Pascagoula River system of southern Mississippi, USA. Population declines led to Federal listing as a threatened species in 1991, with the most robust population inhabiting the lower Pascagoula River in the vicinity of Vancleave, MS (approx. 24 river km from the Pascagoula River mouth). During the spring and summer of 2005, this population was the focus of an endocrinological / genetic study. In addition, turtles were paint marked after capture in order to get a current population estimate of *G. flavimaculata* in the study area. On August 30, 2005, Hurricane Katrina hit the Mississippi Gulf Coast, including our study site. This offered a great opportunity to understand the response of *G. flavimaculata* to one of the most severe natural perturbations in recorded history. This included approximately 190+ mph winds with a 3.6 to 4.5 m storm surge in the study area. In addition to the surge, the river remained at 3.0+ gauge m for 13 days, with normal river levels prior to the storm between 0.9 to 1.2 gauge m. On October 13, 2005, a one hour visual survey by boat through the study area yielded 8 individuals that were paint marked pre-Katrina. These turtles were spotted within the same areas where they were originally marked. For the visual surveys, the Schnabel population estimator was used and indicated a population size of 1203 (2339.1 to 732.0, 95% CI) individuals in a 2 km section of river. We now know that individuals were able to cope throughout the storm, as well as being able to maintain connection to their home range. One issue that is yet to be resolved is the impact of the storm surge (saltwater intrusion) on the food base of *G. flavimaculata*, which includes gastropods and other aquatic macroinvertebrates.

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Is there population structure in the yellow-blotched sawback turtle (*Graptemys flavimaculata*) in a seemingly continuous environment?

The yellow-blotched sawback turtle (*Graptemys flavimaculata*) is a freshwater aquatic turtle that is endemic to the Pascagoula River system of southern

Mississippi, USA. Population declines led to Federal listing as a threatened species in 1991, as well as being listed by the Turtle Conservation Fund/ IUCN as one of the 25 most endangered turtles in the world. However, no research has focused on the population structure of this species. Population structure will be assessed by using morphometric and genetic analyses (microsatellites). During the spring and summer of 2005, we conducted research at three sites in the Pascagoula River basin: (1) north of Hattiesburg, MS, on the Leaf River; (2) south of Leakesville, MS, on the Chickasawhay River; and (3) east of Vancleave, MS, on the lower Pascagoula River. An additional study site on the Pearl River was included using the sister species, the ringed sawback turtle (*Graptemys oculifera*), for morphometric and genetic comparison. Turtles were trapped by using basking traps attached to turtle basking structures. When later approached by boat, turtles were startled into the traps and quickly removed. Once removed from the trap, 1 mL of blood was collected, as well as morphometric data. Morphometric analyses of carapace length using a two factor ANOVA indicated that *G. flavimaculata* have significantly larger carapace lengths than *G. oculifera* ($F_{3,316} = 10.86$, $p = 0.0011$). Additionally, there was a significant difference in carapace lengths between the three sites for *G. flavimaculata* ($F_{3,221} = 3.76$, $p = 0.02$), with Vancleave females and males being the largest. Preliminary analysis of the microsatellite data for *G. flavimaculata* suggests that there could be genetic differentiation among the three different sites, with more extensive data to be presented.

***SERRA-PEREIRA, BÁRBARA; JOYCE, PEDRO; FIGUEIREDO, IVONE; FARIAS, INÊS; MOURA, TERESA; NEVES, ANA; GORDO, LEONEL S.**

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Reproductive dynamics of *Leucoraja naevus* and the role of oviducal gland

Rays are single oviparous species in which the egg production is limited by the ovarian and uterine capacities. They present external embryonic development of encapsulated fertilized eggs. The capsules are produced by the oviducal gland which also plays other important roles such as the production of egg jelly and sperm storage. Although it is generally admitted that spawning in rays occurs throughout the year, the temporal pattern of the reproductive output from mature females along the year is still uncertain for most of the populations. This aspect needs to be clarified to improve the knowledge on the behaviour of different cohorts in the population. This study presents results from the Portuguese project on the reproductive dynamics of *Leucoraja naevus* (Müller & Henle, 1841), using data on ovarian fecundity and on oviducal gland degree of activity, by month. Females in different maturity stages were continuously sampled from Portuguese commercial landings. Histological sections of the

oviducal gland were performed in different zones: the proximal club zone, the papillary zone, the baffle zone and the terminal zone. Oocyte size-frequency histograms by month, particularly the relative frequencies of large oocytes (diam > 2.0 cm), indicated that egg-laying is not a continuous process along the year. The activity of different gland zones varied according to the level of maturation. In mature females before ovulation, the baffle zone, which secretes the capsule material, presented a high accumulation of secretions in the lumen. In the first two uterine stages, during which the formation of the capsule takes place, the club and papillary zones, both responsible for the formation of the egg jelly, were more active. Just prior the extrusion of the egg, it was observed a decrease in activity of the baffle zone and an increase at the terminal zone which secretes fibres deposited on the capsule's surface.

***SEVER, DAVID M.; SIEGEL, DUSTIN S.**

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Sperm aggregations in the spermatheca of the Red Back Salamander (*Plethodon cinereus*)

The spermatheca of *Plethodon cinereus* is a compound tubular gland that stores sperm from mating in early spring (March-April) to oviposition in summer (June-July). The seasonal variation of sperm storage in this species has previously been studied by light and transmission electron microscopy. In this paper, sperm aggregations, interaction of sperm with the spermathecal epithelium, and spermathecal secretions are studied using scanning electron microscopy. Within spermathecal tubules, relatively small groups of sperm are aligned along their entire lengths in parallel arrays. This pattern is similar to other plethodontids with complex spermathecae. Lumina of spermathecal tubules are filled with secretory material in April prior to the arrival of sperm, and after sperm appear, a coating of secretory material persists on the apices of the spermathecal epithelium. Sperm peripheral to the central luminal mass can become embedded in the secretory matrix or pushed deeper into the spermathecal epithelium. The spermathecal secretions may serve to attract and prolong the viability of sperm, but sperm that become enmeshed in the secretions or epithelium are phagocytized. Sperm and spermathecal secretions are largely absent after ovulation and in summer months, and new secretory vacuoles are formed in fall, although mating does not occur until spring.

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Habitat but not body shape affects predator attack frequency on lizards in the Brazilian cerrado

Predators use characteristics such as pattern and shape in forming search images of prey, thereby influencing the evolution of prey morphology. In lizards, sit-and-wait foraging species are thought to have body shapes that enhance their ability to remain cryptic to predators. Structurally complex habitats provide more opportunities for prey to avoid detection, thus predator foraging efficiency is predicted to be higher in structurally simple habitats. I used clay lizard models to test whether predation varies among lizards with different body shapes and whether predation varies among habitats in the Brazilian Cerrado with different structural characteristics. Predator attack frequency was highest in the most structurally complex habitat, but the probability of being attacked was higher in more open microhabitats. Attack frequency did not significantly differ among the four lizard model shapes. Lizards and birds were the main attackers of models and attacks were primarily directed toward the models heads. My results demonstrate that predator-prey interactions are largely influenced by the environmental context and that body shape alone does not efficiently promote crypsis.

***SHERMAN, ELIZABETH; STOOP, KATHERINE**

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Physiological differences among newts from ponds of different pH

We studied physiological responses of newts, *Notophthalmus viridescens*, from three high pH ponds in the Taconic Mountains (average pH=8.1) and three low pH ponds in the Green Mountains (average pH=4.6) of southern Vermont. After 10 days at pH=3.16, 69% of Green Mountain (low pH) newts survived compared to only 23% of Taconic Mountain (high pH) newts. Plasma osmotic concentration, per cent body water, and oxygen consumption were measured in newts from both locations before (untreated) and after treatment for 4 h or 4 d in high pH or low pH. Newts from ponds of different pH exhibited differences in osmoregulation and metabolism. The plasma osmotic concentration and per cent body water of untreated newts taken directly from either high or low pH ponds did not differ. However, pond of origin, duration of exposure, and the interaction of pond x pH treatment contributed significantly to the variation in plasma osmotic concentration. The interaction of pond x duration of exposure and pH treatment contributed significantly to variation in per cent body water. The differences in osmoregulatory responses of newts were not reflected in metabolic differences. Under all treatments, newts from low pH ponds had higher oxygen consumption rates than newts from high pH ponds. It remains to be seen if the physiological differences among newts from different source ponds are due to evolutionary adaptation to different pH.

***SHIVJI, MAHMOOD; PIKITCH, ELLEN; MAGNUSSEN, JENNIFER; CHAPMAN, DEMIAN**

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Application of genetic forensic tools in shark fishery monitoring and law enforcement

Management of shark fisheries in the U.S. and some other countries includes national legislation aimed at preventing landings of species considered especially vulnerable to fishing. Additionally, trade in some of these species (basking, white and whale sharks) is also regulated on an international level due to recent CITES listings. Despite these well-meaning regulations, however, landings and trade of these protected species is suspected to occur due to continued strong market demand for fins, and difficulties in identifying detached body parts. To assist in law enforcement and general monitoring of shark fisheries, we have developed species-specific PCR primers and a rapid assay that currently identifies 28 shark species of regulatory and conservation interest. We will report on our current genetic forensic abilities and present case studies where these techniques have been used to assist law enforcement. Species landed and traded in U.S. fisheries include protected taxa such as dusky, night, sand tiger, bigeye thresher, white and basking sharks. These findings suggest that assessing the effectiveness of fishery regulations will benefit from broader scale monitoring of shark landings by species.

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Hyperdisparate headstanders and static slime suckers: Trends in morphological diversification within the Characiformes

Which anatomical and ecological factors drive some groups of fishes to diversify wildly in morphology while others rarely evolve new shapes? Previously I demonstrated that the morphological diversity of the headstanding characiform fishes in the superfamily Anostomoidea (Anostomidae + Chilodontidae) dwarfs that of the detritivorous Curimatoidea (Curimatidae + Prochilodontidae) and that the unequal diversities are best explained by an underlying shift in the rate of morphological diversification. Until now the absence of a phylogeny for the Anostomidae has precluded a detailed examination of the evolutionary history of these fishes and potential drivers of unequal morphological diversification have been elusive. By combining the recent reconstruction of the anostomid

phylogeny (see the accompanying poster by Sidlauskas and Vari) with morphometric data from each species, I show that phylogenetic trends in morphological diversification have been very different in the two superfamilies. The Anostomoidea have evolved novel morphologies throughout their phylogenetic history while morphological innovation in the Curimatoidea is concentrated near the base of the phylogeny. A map of ecological and anatomical synapomorphies for both clades reveals a suite of characters that may have promoted morphological diversification in the Anostomoidea or restricted morphological change in the Curimatoidea. For example, the early evolution of a greatly lengthened quadrate in the Anostomoidea may have decoupled the joint of the lower jaw from the neurocranium and eliminated biomechanical constraints on certain jaw morphologies. Alternatively, the evolution of a detritivorous lifestyle in the Curimatoidea allows that clade to exploit a superabundant food resource and may have obviated further changes in jaw morphology. It will be necessary to examine other case studies to distinguish conclusively among these hypotheses, so I conclude by outlining a future study of characiform evolution on South America and Africa which will take advantage of parallel evolutionary events to help determine whether cranial decoupling, detritivory, or other aspects of morphology and ecology tend to promote or restrict morphological diversification whenever they arise.

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Phylogenetic relationships within the South American fish family Anostomidae (Ostariophysi, Characiformes)

Maximum parsimony analysis of a morphological dataset containing more than 100 characters has yielded the first phylogenetic reconstruction spanning the entire South American characiform family Anostomidae. The reconstruction includes 44 ingroup species representing all anostomid genera and subgenera. Outgroup comparisons include members of the sister group to the Anostomidae (the Chilodontidae) as well as members of the characiform families Curimatidae, Prochilodontidae, Characidae, Distichodontidae and Citharinidae. Most characters were discovered in the highly variable cranial skeleton; some characters were discovered in the axial and appendicular skeletons, pigmentation, and soft anatomy. Our results support the monophyly of a clade containing the genera *Anostomus*, *Gnathodolus*, *Pseudanos*, *Synaptolaemus* and *Sartor* (the subfamily Anostominae sensu Winterbottom) but our analysis supports a somewhat different set of relationships among the species within these five genera than Winterbottom proposed. *Laemolyta* appears to be the sister group to the above clade. *Rhytiodus* and *Schizodon* together form a well supported

clade, as does a subgroup of the genus *Leporinus* characterized by a banded color pattern. Taken as a whole, however, *Leporinus* appears to be a grade-level concept and is not monophyletic. *Leporellus* appears to be the most basal anostomid genus. Some of the most remarkable morphological shifts in anostomid evolution are illustrated and discussed, including several instances of convergence or parallelism. Perhaps the most dramatic of these is the multiple evolution of a trough-like morphology of the ascending process of the anguloarticular, which occurs in two groups of species with subterminal mouths that are not hypothesized to form a monophyletic group under our reconstruction.

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Sperm storage in *Agkistrodon piscivorus* females

Agkistrodon piscivorus is a common species in Southeastern United States. However, research on the reproductive biology of this species is very limited. As part of a comprehensive study of the reproductive life history of *Agkistrodon piscivorus*, areas of female sperm storage are located and identified using light microscopy and electron microscopy. From these techniques, the areas of sperm storage were found to be the utero-vaginal junction and the utero-infundibular junction. The sperm storage tubules (SST) can be characterized as simple branched tubular glands and contain ciliated and secretory cells in an alternating pattern. Sperm are present in these SSTs in late July and specimens collected in August through November, prior to hibernation, also possess sperm. This leads us to believe that copulation occurs in late summer and fall, sperm is stored throughout the winter months, and ovulation and fertilization would therefore occur in the spring.

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Testing methods for estimating natural mortality in fish populations: A simulation study

Natural mortality, M , is a life history parameter in most stock assessment models. Very often it is treated as a constant, but there are a multitude of methods available to estimate the parameter. We review the methods available since the review by E. Vetter in 1988, and test each method using a simulated population. Our simulation is based on parameters of blue shark (*Prionace glauca*) with three aspects to their natural mortality: density independent, size dependent, and age dependent components. We find that methods based on life

history invariants perform poorly in comparison to methods based on size or age. We recommend a new assessment of the methods and combination of age- and length-based estimation techniques.

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Can habitat suitability models be used to help recover the smalltooth sawfish population?

The distribution of areas important to the conservation of the endangered smalltooth sawfish was examined using habitat suitability models that utilized data from public encounters and research surveys. Public encounter data indicated that there was a significant correlation between the occurrence of juvenile sawfish (<200 cm) and the presence of shallow depths (<90 cm), mangroves and shorelines, but not seagrasses. There were significant positive size relationships in the distances from mangroves, shallow depths and shorelines with the size of sawfish. Public encounter data and research surveys also indicated that juvenile sawfish less than 200 cm in length were most commonly associated with estuarine conditions. Habitat suitability models were constructed using the distances to mangrove shorelines, shallow depths, and presence of estuarine conditions. Models with all combinations of these three factors were constructed and assessed using cumulative frequency plots of distance between encounters and areas of high habitat suitability. The three parameter model was found to best represent the data. The model provided the best fit to data in areas south of 28°N where mangroves most commonly occur. The implications of the results for conservation planning for this endangered species will be discussed.

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Molecular characterization of a hybrid zone between the gars *Lepisosteus osseus* and *L. platostomus* in the Fox and Wolf River system of eastern Wisconsin

The gars *Lepisosteus osseus* and *L. platostomus* are known from the Fox-Wolf River system (Lake Michigan basin) in east-central Wisconsin, but many gars from this system have unusual snout dimensions and pigmentation patterns and cannot be clearly assigned to either species. In particular, some specimens have snout morphology intermediate between the typical *L. osseus* and *L. platostomus* forms, and some specimens with *L. platostomus*-type snout morphology have snout and dorsal spotting patterns more typical of *L. osseus*. *Lepisosteus osseus* is native to the Fox-Wolf system, but *L. platostomus* is thought to be a relatively recent invader, either through a historical natural connection during flooding between the upper

Fox River and the Wisconsin River (Mississippi River basin), or via a canal connecting these rivers from the mid 1800s through 1951. We used morphological and genetic (partial cytochrome *b* and complete mitochondrial D-loop sequence data) comparisons between Fox-Wolf and Wisconsin River gars to determine if the unusual gars in the Fox-Wolf system were *L. osseus* X *L. platostomus* hybrids. In the Wisconsin River, snout morphology and pigmentation were clearly distinctive and as expected between specimens identified as *L. osseus* or *L. platostomus* based on cytochrome *b* and D-loop haplotypes. No intermediate morphology or pigmentation was found. However in the Fox-Wolf, specimens with either the *L. osseus* or *L. platostomus* haplotypes had a wide range of snout morphology and pigmentation, including intermediate forms. Some specimens with *L. platostomus*-type morphology and pigmentation had *L. osseus* haplotypes and vice versa. We conclude that many specimens in the Fox-Wolf are hybrids between *L. osseus* and *L. platostomus*. These are the first gar hybrids ever reported in nature.

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Hidden diversity within the *Fundulus notatus* species complex in Mississippi

Topminnows (Family Fundulidae) include nearly 35 species that inhabit a wide range of habitats and environmental conditions. Members of this group have been the subject of much systematic research, although relationships among taxa and between subgenera are still not completely resolved. The *Fundulus notatus* species complex is comprised of the blackstripe topminnow (*Fundulus notatus*), the blackspotted topminnow (*F. olivaceus*) and the broadstripe topminnow (*F. euryzonus*). Within the complex, *Fundulus notatus* and *F. olivaceus* are the most widely distributed species, while *F. euryzonus* is endemic to the Lake Pontchartrain drainage of Louisiana and Mississippi. Taxonomy within the complex has remained stable since the description of *F. euryzonus* in 1981, although most researchers would agree that taxa within the complex may be polytypic. Research efforts within the DeSoto National Forest, Mississippi, revealed a unique form of the *Fundulus notatus* species group which is currently considered endemic to Mississippi. Examination of museum records (ca. 1,600 lots) to date suggests the form is restricted to the Pascagoula drainage occurring in at least 3 separate watersheds. Occurrence is generally limited to cool, flowing headwater reaches of small to medium-sized blackwater streams with extensive bank-side canopy development and a substratum comprised primarily of sand and woody debris. The new form is most similar in appearance to *Fundulus euryzonus*, but differs based on pigmentation characteristics (lateral stripe,

median fins). It differs from *Fundulus olivaceus* and *F. notatus* in terms of meristic counts (dorsal rays) and pigmentation characteristics (dorsum spotting, lateral stripe, rictus pigment).

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Temperature and body mass influence rates of molecular evolution in cyprinid fishes

Variability in rates of molecular evolution compromises application of molecular rates to tests of the relationship of divergence and biogeographical events to geological events. The mass-specific metabolic rate hypothesis of Gillooly and others predicts that mutation and substitution rates are a function of body mass and temperature. We tested this hypothesis with genetic distances estimated from cytb and ND4L sequences of 54 taxa of North American cyprinid fishes. Branch lengths from a maximum likelihood phylogenetic tree were compared with metabolic rates calculated from body mass and environmental temperatures. Tests of the predicted monotonic relationship between metabolic rate and change in mtDNA support the hypothesis that faster metabolic rate significantly corresponds to faster rate of molecular evolutionary rate in temperate minnows. Temperature and body mass account for 45% to 65% of the variation in substitution rate. Application of this approach to *Rhinichthys* shows rapid evolution in the east and southwest; slower evolution in the north.

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Changes in desert lizard ecology before and after golf course construction

We characterized lizard activity and abundance on and between 80 rockpile plots before and after construction of a golf course in the Sonoran Desert near Tucson, Arizona. We observed 4032 lizards of 13 species during 192 survey-mornings. Construction of the golf course and associated roadways rendered only a few plots unusable by lizards, with many of the rockpiles being incorporated into the design of the course itself. We assessed how disturbances associated with golf course construction influenced lizard relative abundance, diversity, and habitat use. While pre- and post-construction surveys yielded similar numbers of lizards overall, changes in species composition were related to the degree of disturbance. We discuss how water availability on golf courses may enhance habitat for some lizard species in arid environments. We hope our findings will equip golf course designers and managers with information necessary to enhance or maintain golf courses as suitable habitat for lizards.

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Cryptic speciation of agamid lizards in the tropical savannahs of northern Australia: Phylogeography of *Diporiphora bilineata* and *D. magna*

The ability to identify species is an important prerequisite for many studies in evolutionary biology and ecology. The development of molecular ecology techniques have permitted the discrimination between previously unrecognised morphologically similar species. Labelled cryptic species, their existence can be explained by factors such as incomplete morphological differentiation following recent speciation or similar selection pressures in historically isolated lineages. *Diporiphora magna* and *D. bilineata* represent two morphologically indistinguishable agamid lizard species that are widely distributed throughout the savannah region of tropical northern Australia. These species show an array of body size and patterning throughout their overlapping ranges, leading to taxonomic uncertainties and difficulty identifying species boundaries. We undertook a the first phylogeographic study of *Diporiphora*, in order to determine if these populations of *D. magna* and *D. bilineata* belong to a single clade or constitute a number of genetically distinct cryptic species. We collected lizards from throughout their distribution and sequenced a 1500bp region of mtDNA. Phylogenetic analysis revealed the existence of seven clades that show deep evolutionary divergences (uncorrected genetic distance 8-15%). A number of these clades also differ morphologically and in microhabitat use. Mantel tests showed that some aspects of morphology were significantly correlated to phylogenetic relatedness, however there was no correlation between morphology and habitat occupation when controlled for phylogenetic relatedness. These results suggest morphological adaptation to local microhabitats is unlikely and that other evolutionary processes have led to morphological differences between clades. Phylogeographic analyses suggest that these seven clades diverged, through isolation and/or local adaptation, from a more widespread species at least five million years ago. The results of our study suggest *D. bilineata* and *D. magna* represent a diverse species complex, highlighting the importance of phylogenetic techniques for understanding the evolutionary patterns of ecological and morphological diversity within widespread species.

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Patterns of Eastern Tiger Salamander migration at a seasonal wetland in southwest Georgia

We examined breeding activity and migration patterns of eastern tiger salamanders, *Ambystoma tigrinum tigrinum*, at a drift fence around an isolated wetland in southwest Georgia. The study wetland lies within a landscape of fire-maintained longleaf pine savanna, mixed-hardwood forests and wildlife food plots, which allowed us to evaluate movement patterns within a complex habitat matrix. The adult breeding population ranged from 70 to 163 adults over three consecutive seasons and recruitment ranged from 27 to 741 metamorphs over the same period. The distribution of salamander captures around the wetland edge was non-random and appeared to be associated with distance to wildlife food plots. Most recaptured individuals entered and exited the wetland within 40 m of their original capture site both within and between breeding seasons (81 and 76%, respectively). Four radio-tagged emigrating salamanders moved up to 255 m from the wetland and inhabited burrows in forested land and wildlife food plots. Based on the extent of terrestrial movements by eastern tiger salamanders, our findings support previous work demonstrating that upland habitats surrounding wetlands are critical areas in amphibian life cycles and that individual species may have specialized terrestrial habitat requirements.

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Spatial ecology and influence of predators on Gopher Tortoise nests and hatchlings

We examined survivorship, movements, space use and burrow use of Gopher Tortoise (*Gopherus polyphemus*) hatchlings in southwest Georgia. Forty hatchlings from 13 nests were radio-tagged and tracked for periods ranging up to 319 days. Thirty two hatchlings were located within predator exclosures and 8 were located at unfenced control sites. Survivorship at controls was 38% as compared to 78% in exclosures. Hatchlings monitored at least 90 days occupied a mean area of 26.41 m² and constructed their first and final burrows 7.35 and 12.19 m from their nest of origin, respectively. Over three years, nests in exclosures and controls experienced 40% and 80% depredation rates, respectively.

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Ecology and conservation of large terrestrial snakes in the longleaf pine ecosystem: Do upland snakes partition resources?

Surprisingly little is known about the habitat requirements of large upland snakes in the Southeastern Coastal Plain. In this study, we monitored snake populations in a longleaf pine forest in southwest Georgia for three years using snake trap arrays. We captured 354 individuals of 17 species; the most common species captured were black racer (*Coluber constrictor*; 82), coachwhip (*Masticophis flagellum*; 58), garter snake (*Thamnophis sirtalis*; 37), and eastern hog-nosed snake (*Heterodon platirhinos*; 37). Ten adult eastern kingsnakes (*Lampropeltis getula*) have been radio-tagged to determine home range size and habitat use and to describe winter refuge sites. Preliminary data indicate that southeastern pocket gopher (*Geomys pinetus*) runs, small mammal burrows, and stump holes are frequent refuge sites of this species. We plan to radio-tag adult coachwhips and Florida pine snakes (*Pituophis melanoleucus mugitus*) in 2007 to determine how these three large upland snake species partition longleaf pine habitat.

SMITH, WM. LEO

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The advantages of combining morphological characters with DNA sequences: An example from the Percomorpha

During the last ten years, there has been a dramatic increase in the number of phylogenetic studies that have relied exclusively on molecular data. Many of these studies have been illuminating, but they have also produced some results that are at the very least unorthodox, if not bizarre. It has been shown that some of these problems can be solved by increasing taxonomic sampling and/or character sampling, to a lesser degree. Although the addition of morphological and behavioral characters has been paid much lip service with regard to resolving these problems, few large-scale studies of fishes have incorporated phenotypic data. I will show an example from my studies of mail-cheeked fishes that illustrates the power of combining phenotypic and genotypic data for approximately 100 acanthomorph species. This study, based on 197 phenotypic transformation series and approximately 4,200 base pairs from both the mitochondrial (12S, tRNA-Val, 16S) and nuclear (histone h3, 28S, TMO-4c4) genomes, resulted in relationships that are more consistent with the traditional view of mail-cheeked fishes than either the results from the morphological or the molecular analyses alone. The general pattern indicates that the sculpins and their allies form a clade with a series of scorpionfish, flathead, sea robin, etc. clades being resolved as a paraphyletic grade leading toward the sculpins. This study highlights the power of analyses combining genotypic and phenotypic

data, and it should serve as a warning to researchers who rely on cladograms based exclusively on molecular or morphological data.

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Sampling the unsampled: cryptic coral reef fishes of Buck Island

Because cryptic fishes are difficult to accurately survey, they are undersampled components of coral reef habitats. Fifty-eight enclosed stations were sampled in shoreline, nearshore reef, lagoon, backreef, forereef, and bank/shelf habitats with an ichthyocide (rotenone) at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands. Our samples included 228 fish species in 55 families, including 60 species previously unreported from St. Croix. Fish assemblages varied across habitat zones with the shoreline assemblage the most distinct. Only 8% of the species were present in all habitats. Multi-dimensional scaling plots of habitat characteristics and Bray-Curtis similarities of fish assemblages revealed similar patterns. Rotenone and visual census data were compared. While visual surveys accumulated more species per unit of effort, rotenone samples accumulated more species by area. Only 36 % of the 228 species sampled with rotenone were visually detected, while 70% of the 115 species visually detected were also collected with rotenone. The use of rotenone is controversial but important for obtaining reasonably complete inventories of reef fishes.

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Modeling hydrology and fish occurrence in isolated wetlands to identify wetland complexes for management

It is widely recognized that isolated wetlands are important habitats for a range of amphibian species and that their conservation will be essential in protecting amphibian diversity. However, a wetland-by-wetland approach to conserving and managing isolated wetlands is not likely to be an effective strategy because hydroperiods (the duration of surface water presence during the annual hydrological cycle) and the occurrence and types of top predators vary greatly among wetlands and among years within wetlands; and amphibian species are often adapted to specific hydroperiod and predator occurrence combinations and require adjacent uplands to complete their life cycles. Therefore, it is recommended that landscapes of isolated wetlands be protected and managed as units to provide the range of hydroperiod and top predator occurrences that

support amphibian diversity associated with these wetlands. Operationally, land managers currently have little guidance in identifying and prioritizing isolated wetland landscapes for conservation purposes. We used information on the occurrence of surface water and fishes in 91 wetlands on the Upper Coastal Plain of South Carolina to generate classification tree models of hydroperiod and fish occurrence based on wetland habitat conditions and landscape position. We then hierarchically clustered wetlands based on their geographic location and assessed diversity in predicted hydroperiod and fish presence/absence within clusters to identify the spatial extent of wetland landscapes that would provide protection of the range of hydroperiod and fish presence/absence conditions found in these systems. The size of wetland landscapes identified as encompassing diversity of hydrological and predatory conditions among wetlands often closely corresponded to the area of small stream watersheds, but not all small watersheds contained the complete range of variation needed to conserve amphibian diversity associated with isolated wetlands. Our approach should provide land planners with guidance in selecting management units for isolated wetlands.

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Population differentiation of *Prochilodus nigricans* (Prochilodontidae, Characiformes) in the Peruvian Amazon using microsatellite analysis

The large migratory detritivorous fishes of the genus *Prochilodus* are the most abundant and ubiquitous freshwater taxon living in South American Rivers. This continental distribution makes them ideal organisms to examine basin affinity and population structure. In this study we use microsatellites in *Prochilodus nigricans* from seven populations of the Peruvian Amazon and two outgroup populations of *P. mariae* from the Orinoco basin to assess levels of gene flow within and between these major basins. This analysis is part of an effort to investigate species boundaries with molecular markers, following the application of mitochondrial and nuclear DNA sequence data. The distribution of *P. nigricans* is associated with the Amazon River and its tributaries whereas *P. mariae* is restricted to the Orinoco. However, connections between these basins allow potential gene flow. Preliminary results of microsatellite genotypes suggest lack of differentiation among *P. nigricans* populations living in headwater tributaries of the Amazonas in Peru. AMOVA showed that 98% of the variation at two loci was within populations ($F_{st}=0.02$). When all these headwater samples were grouped and compared to *P. mariae* populations from the Orinoco, AMOVA showed 90% of variation within populations (only 10 % of the variance explained between species, and $F_{st}= 0.09$). These preliminary results are congruent with mtDNA and nuclear genealogies, suggesting extensive levels of gene flow among subpopulations and porous interspecific boundaries.

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Innervation, orientation, and homology of the cephalic lateral line pattern in gobies: A phylogenetic interpretation based on new keys from evo-devo studies

Patterns of the lateral line neuromast (sensory papillae) are important morphological characters in gobioid taxonomy. Complexity of the pattern, makes the phylogenetic interpretation of this character in systematic analysis of gobies difficult (Miller 2005). Recently, studies on gene expression, embryonic genes and postembryonic growth of the lateral line system reveal some mechanisms of the pattern formation. The new knowledge on the primordial migration, neuromast deposition, and the role of the glia-axon-lateral line precursors during the development that brings us to a new dimension of understanding the

innervation and homology of the lateral line patterns. This study is following the timing and sequence of the lateral line nerve branching and the distribution/orientation of the neuromasts pattern formation, to analyze their adult patterns in thirteen species of gobioid fish (from five groups: Rhyacichthyidae, Odontobutidae, Butinae, Eleotridinae, and Gobiinae). The results lead to a new proposal of homology of the mixed, reduced, longitudinal, and transversal patterns. A phylogenetic interpretation of the sensory papillae pattern in gobioid systematics is proposed.

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Diel activity patterns of *Bothriechis schlegelii* as indicated by predatory behavior

The nocturnal/diurnal dichotomy used to describe the activity of animals is often an oversimplification of nature. The literature available on *Bothriechis schlegelii* reports this species to be nocturnal. *B. schlegelii* is an ambush predator that preys upon a wide variety of vertebrates. The observation of diurnally- and nocturnally-active prey in the diet of this species indicates that this snake does not limit its predatory activity to a discrete period within a 24-hour cycle. The goal of this project is to define the diel activity pattern of *B. schlegelii* as indicated by the ability of individuals to respond to potential prey. I hypothesize that time of day influences predatory activity in *B. schlegelii*. A review of the literature leads me to predict that predatory activity will be greater at night. In situ prey introductions (using *Norops limifrons*) were conducted with perched snakes. The response of each snake was assigned to one of two categories: 1) did not strike; 2) struck. Trials were conducted during the daytime (n=16) and at night (n=11). The results indicate that time of day has a significant effect ($G=3.86, =0.049$) on the predatory activity of *B. schlegelii*, yet contrary to my prediction, more strikes were observed during the day. This study suggests that *B. schlegelii* has a greater temporal activity range than previously documented. Having the ability to take prey during both night and day increases the importance of the role of *B. schlegelii* as predator of small vertebrates.

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Patterns of use of anthropogenically-fragmented habitat by an arboreal pitviper

Loss of habitat has been identified as the most significant threat to biodiversity in the tropics. Conversion of forested habitat resulting from agricultural practices is

a major contributing factor to this process. With the continued increase in human population, trends of habitat modification due to agriculture will surely continue. The fact that many species will survive only if they tolerate some level of habitat modification underscores the necessity for studying the ways in which wildlife respond to anthropogenic fragmentation. While many studies of fragmentation effects have focused on birds and mammals, few have focused on snakes, especially tropical species. This study examines the effects of cattle production on habitat use of the eyelash viper, *Bothriechis schlegelii*. This work was done in western Panama, and the site is comprised of pastureland with islands of trees interspersed within a matrix of grasses and small shrubs. *B. schlegelii* is an arboreal species most common in lowland tropical forest. At this site *B. schlegelii* inhabits the isolated tree islands found throughout the pasture. The objective of this study is to determine what habitat variables limit the distribution of *B. schlegelii* in this fragmented landscape. Variables include island size, island isolation, vine coverage, presence of buttresses, and proximity to fences. Island area and vine coverage were positively correlated with snake abundance whereas island isolation had a negative correlation. Presence of buttresses and location of fences did not influence snake abundance. My results indicate that small pastures with scattered tree islands that maintain vine coverage provide some suitable habitat for *B. schlegelii*. This suggests that small-scale cattle production may be performed in a way that provides some of the habitat requirements necessary for sustaining *B. schlegelii* populations.

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The occurrence of juvenile white sharks (*Carcharodon carcharias*) in the northwestern Mexico

White sharks (*Carcharodon carcharias*) have been recorded throughout the North Pacific, from cold temperate coastal to tropical waters. In the Gulf of California, *Carcharodon carcharias* has been reported only in the southern part, close to the mouth of the gulf. In this study we report the characteristics of five juveniles white sharks caught by fishing vessel in the Upper Gulf of California during the summers of 2002, 2003 and February 2005; as well as the stomach contents of three of these sharks. Juvenile shark sizes ranged between 212 and 236 cm in total length (TL). The principal food items were bony fishes and rays (Rhinopterae). Additionally, five juvenile white shark jaws were collected at garbage dumps near a fishing village at the Pacific coast of the middle Baja California Peninsula.

The calculated size of these juveniles ranged between 199 and 243 cm TL. The importance of the Gulf of California for this species will be discussed and some of the management issues in the region.

SPAETH, JOHN P.

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Spatial patterns and community associations of ecologically-similar fishes of south Mississippi

The southeastern United States has the greatest freshwater fish diversity in North America. The potential for strong interspecific interactions are likely among community members within this region. To investigate community structure patterns and potential competitive relationships, monthly community samples were collected from 15 sites in 2nd to 4th order streams in the Pascagoula River drainage in south Mississippi. Assemblages remained similar within each stream and relatively stable over time at each site, despite disturbances. Abundance patterns of ecologically-similar fishes collected in allotopy and syntopy suggested that spatial segregation occurred at various scales. Dominant species-pairs of the genera *Ammocrypta*, *Percina*, and *Etheostoma* showed disparate community associations. The changes in abundance patterns observed when species-pairs occur in syntopy suggest potential competitive avoidance and calls for further investigation into patterns of resource utilizations.

SPENCER, CAROL L.

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Introduction and contributions of Joe Slowinski to the fields of herpetology and phylogenetics

From 1985 to 2005, Joe Slowinski published over 46 articles and a book on the topics of herpetology, theoretical phylogenetics, genetics, ornithology, botany, and paleontology. Six of these articles were published posthumously. He performed research in the United States, the Neotropics, and most recently, the Old World Tropics. Joe's roots were in Kansas; he was fascinated with paleontology and discovered some fossils that are now displayed at the University of Kansas Natural History Museum in Dyche Hall. Although he was most well known to us as an avid herpetologist, he was equally famous for his work in theoretical phylogenetics. Joe published 16 articles related to molecular clocks, divergence times, alignments, patterns of speciation and diversity, and most importantly, several pre-eminent articles with Craig Guyer on tree shape (topology). Slowinski and Guyer recently were cited in Mooers and Heard

(Systematic Biology, 2002) as having published papers that played an important role in inspiring and shaping the subsequent spread of research on tree shape. Joe's main love was herpetology, and he pursued this with a passion, publishing 28 articles on topics in herpetological ecology, phylogenetics and general herpetology. He especially liked the phylogenetics of the Elapidae and higher snakes. His dissertation was on coral snake phylogenetics and 18 papers since were about elapid and higher snake relationships. His passion for these fields is reflected by his influence. Since his death, two funds have been established in his name, a book about his life is in the works, and three species have been named after him, including *Elaphe slowinskii*, *Bungarus slowinskii*, and *Cyrtodactylus slowinskii*. A yet unnamed frog also will bear his moniker. This year marks the fifth anniversary of Joe's death (12 September 2001). We hope to make him proud by presenting this symposium of talks by his friends and colleagues.

***SPENCER, CAROL L.; TRUEB, LINDA; WAKE, DAVID B.; KOO, MICHELLE S.**

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Herpnet: A new and improved one-stop shop for amphibian and reptile collections data

The importance of museums and their collections to the study of biodiversity cannot be overstated. These collections provide critical data for addressing a diversity of issues, including phylogenetic, conservation, and biodiversity questions. The HerpNet database (www.herpnet.org) combines amphibian and reptile museum databases from 51 museums throughout the world. Recently, we added 12 institutions, including five North American collections (Fort Hays State University, Santa Barbara Natural History Museum, University of Alabama, University of Alaska, Utah Museum of Natural History) and seven international collections (Australian Museum, Sydney; Chengdu Institute of Biology, China; Muséum d'Histoire Naturelle de la Ville de Genève, Switzerland; Raffles Museum of Biodiversity Research, Singapore; Royal Museum of Central Africa, Belgium; Staatliches Museum für Naturkunde Stuttgart, Germany; Zoological Institute, St. Petersburg). We received funding from GBIF (Global Biodiversity Information Facility) to database and georeference these seven international collections that have large holdings (> 425,000) of amphibians from rare localities (Africa, Australia, China, Eastern Europe, Southeast Asia, New Guinea, and Russia). In the near future, HerpNet will provide more than four million specimen-data records representing 700,000 unique localities worldwide. Currently, HerpNet provides coordinates for data from across the western United States. We will finish georeferencing all North American localities and international collections by September 2007. Currently the HerpNet data portal is being improved to make it easier for both researchers and the general public to use. New features available in the next year include: direct links to HerpNet data and maps from AmphibiaWeb (www.amphibia.org), expert opinion maps from Global Amphibian Assessment, and the ability to search under synonymous taxonomy. Herpetologists, conservation biologists and museum scientists alike can use HerpNet data for a diversity of GIS, ecological, and phylogenetic research.

***STAIGER, JENNIFER S.; BARICHIVICH, WILLIAM J.**

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Terrestrial herpetofaunal community structure along a faunal break in north central Florida

The lower Suwannee River region of north central Florida is a biogeographically complex area. Several amphibian and reptile species reach the southern or northern (at least along the Gulf coast) limits of their ranges in the area, and it is also a zone of subspecific differentiation for several species. We examined the structure of terrestrial herpetofaunal communities at 10 sites along the Suwannee River in Lower Suwannee National Wildlife Refuge, Florida. Five sites were located along the north side of the river in Dixie Co., and five sites were located in Levy Co. south of the river. Thirty-four species were trapped at drift fence arrays in the 10 sites between May 2003 and February 2005, totaling 646 individual captures (recaptures excluded) over 381 array nights. We compare species diversity, capture rates, and similarity indices. Capture rate and species richness were lower at the northern sites, where 22 species of reptiles and amphibians were trapped, including five species not captured at the southern sites. Twenty-seven species were trapped at the southern sites, including eight not captured at the northern sites. The majority of captures were frogs (*Hyla squirella*, *Rana sphenoccephala*, *Gastrophryne carolinensis*, *H. femoralis*), with two or three of these species contributing to the majority of similarity in community structure when comparing sites on the same side of the river. Some of these same species also contribute to the majority of dissimilarity when comparing sites across the river, likely due to differences in capture rates. Sites south of the river are more similar to each other in community structure than northern sites are to one another, despite the southern sites representing greater habitat diversity. Our analyses reveal possible differences in herpetofaunal community structure to the north and south of the lower Suwannee River.

***ST.-AMOUR, VALERIE; LESBARRERES, DAVID**

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The role of emergent infectious diseases in relation to fluctuating asymmetry in the green frog (*Rana clamitans*)

Amphibian populations are facing rapid declines and recent discoveries have shown that Emergent Infectious Diseases (EIDs) such as Ranavirus and Chytrid fungus are playing major roles. Although these diseases are involved in the decline of certain populations little is known about the effects of these EIDs in relation to development. Developmental stability can be measured using fluctuating asymmetry (FA) which is often used as a tool to measure stress and the overall fitness of organisms. The theory assumes that an organism presents mechanisms that control asymmetry during development. Such mechanisms may be costly to the individual and when faced with other stressors it is believed that these mechanisms will suffer resulting in fluctuating asymmetry. Since secondary sexual traits are more costly than non-sexual traits we also expected to observe FA in the former rather than in the latter. Using genetic tools, several populations of green frogs (*Rana clamitans*) were analyzed for presence or

absence of chytrid fungus as well as Ranavirus. Infected and non infected individuals were then measured to determine FA under the hypothesis that FA will be more likely to be observed in individuals infected by one or both of these diseases. Results showed significant difference in fluctuating asymmetry when comparing sexual traits among infected and non-infected individuals. This shows that not only are EIDs causing massive die offs they are also having a further reaching effect on the development of those individuals carrying the diseases.

***STEELE, CRAIG A.; GIORDANO, ANDY; STORFER, ANDREW**

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Comparative patterns of gene flow and dispersal in sympatric species of giant salamanders (*Dicamptodon*)

Few studies have examined how a common landscape affects genetic structuring of sympatric species. We present results from a study examining gene flow patterns between two species of sympatric stream-breeding salamanders: the Pacific giant salamander (*Dicamptodon tenebrosus*) and Cope's giant salamander (*D. copei*). Metamorphosis into a terrestrial adult is extremely rare in *D. copei*, while the opposite is true for *D. tenebrosus*. We predict that the different frequencies of terrestrial adults will affect relative rates of gene flow, resulting in higher levels of genetic connectivity among populations of *D. tenebrosus* than among populations of *D. copei*. Because migration between populations can occur either via direct overland dispersal or along waterways, we also test predictions that population structure in the two species is best explained by either overland dispersal or by stream dispersal. Movement between populations of *D. tenebrosus* is hypothesized to occur primarily by overland dispersal of terrestrial adults, resulting in patterns of population structure best explained by an isolation-by-terrestrial-distance model. In contrast, neotenic populations of *D. copei* individuals are constrained to their natal streams and migration among localities is predicted to occur primarily along stream routes, resulting in patterns of population structure best explained by an isolation-by-stream-distance model. Using microsatellite loci we test the general prediction that higher levels of genetic connectivity exist for metamorphosing populations of *D. tenebrosus* than for non-metamorphosing *D. copei* and test patterns of genetic structuring against the two dispersal models. Results from this project compare the dispersal capabilities and genetic structure of these two amphibian species and provide general insight on the influence of life history variation on genetic structure of populations.

***STEELE, MARK A.; SCHROETER, STEPHEN C.; PAGE, HENRY M.**

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Experimental evaluation of biases associated with sampling estuarine fishes with seines

Seines are commonly used to estimate the density and species richness of estuarine fishes. We evaluated the extent and causes of bias in estimates from seines using a series of field experiments in estuaries in southern California, USA. Seining in spatially paired areas that were either enclosed by block nets or not, revealed that seines used without block nets underestimated density (by 4 fold) and species richness (by 2 fold) relative to blocked areas. Seining in paired

blocked areas with seines of two lengths revealed that net length affected estimates of density but not species richness: a 7.6-m-long seine produced 1.6-fold higher estimates of density than did a 15.2-m-long seine due to increased catches of demersal fishes. Paired sampling in blocked areas also revealed that many fishes, especially demersal species, initially evaded capture by the seine. Estimates of density, but not species richness, were significantly higher in areas swept 5 times by a seine than areas swept only once. Repeated seining (10 sweeps) through blocked areas revealed that the vast majority species (90% of species richness) and individuals of midwater fishes (92% of density) were captured within the first 5 hauls through the area; but only about 50% of the individuals of demersal species were captured after 5 hauls. A mark-recapture study in blocked areas also revealed lower probabilities of capture for demersal species relative to midwater species (30% vs. 70% respectively). Lower probability of capture for demersal species relative to midwater species biased estimates of community structure, but such bias can be corrected if it is measured. Overall, we found beach seines to be useful tools for estimating density and species richness of estuarine fishes, provided that their biases are accounted for.

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Habitat use of sympatric rattlesnake species within the gulf coastal plain

The eastern diamondback rattlesnake (*Crotalus adamanteus*) and timber rattlesnake (*Crotalus horridus*) are sympatric throughout most of southern Georgia. We used rattlesnake sightings over a four year period to quantify and compare habitat use by these two species in the Gulf Coastal Plain. Univariate statistics and logistic regression models indicated that *C. adamanteus* was a habitat generalist associated with a large, intact habitat matrix of both longleaf pine and mixed pine/hardwood forest. In contrast, *C. horridus* was closely associated with hardwood habitat and riverine systems, but not with roads and habitat edges on a large scale. These species may partition resources by disparate habitat selection. To effectively conserve and manage both species in the southeast, a habitat matrix of large intact patches of both hardwood and pine forest may be necessary.

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Carotenoid-based dewlap coloration correlates with male dominance over females in the Brown Anole, *Norops sagrei*.

Animals use a broad class of pigments to color their integument. One of the best studied integumentary pigment classes are carotenoids. Carotenoids are a well-studied pigment class because they have been shown to act as honest indicators of signaller quality in fish and birds. Pteridines are a less studied integumentary pigment but which are relatively common in many animals. Few studies to date investigate the potential for pterin-based pigments to act as condition-dependent signals. Virtually no studies have investigated condition-dependent qualities of carotenoid- or pterin-based pigments in lizards. *Norops sagrei*, the Brown Anole, is an invasive lizard found throughout Florida and the southeast U.S. that possesses a throat fan (or dewlap) that is colored by carotenoids as well as pteridine pigments. I present data that show that carotenoid-based spectral properties (and not pterin-based spectral properties) indicate body condition. I also present results of natural experiments between males for dominance over females in which males that possess dewlaps with spectral qualities related to greater carotenoid concentrations have greater courtship success than males that have lower carotenoid concentrations. Pterin-based dewlap color did not correlate with dominance. Male and female Brown Anoles may detect this dewlap color variation and use it make decisions about choosing battles and mates.

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Latest battle in the “War Of The Iguanas”: Phylogenetic analysis of Iguaninae using multiple markers

Iguaninae is an ancient group with eight modern genera distributed throughout the Western Hemisphere and in the Fijian archipelago. Previous morphological and molecular studies of Iguaninae relationships have relied on incomplete sample sets that yield conflicting topologies. The subfamily collectively spans thousands of miles across multiple geographical boundaries, and exhibits a high degree of regional and island endemism. Because of its age and distribution, the group is uniquely suited to test biogeographic hypotheses, such as suggested occurrences of past refugia or relictual fragments. A well-supported phylogeny of this subfamily will also allow empirical evaluation of molecular clock models since it exhibits a wide spectrum of lineage divergences against the well-studied Cenozoic geologic history of the neotropics. In order to generate a robust phylogeny we have collected DNA sequence data at four loci (2 nuclear and 2 mitochondrial) for all eight genera, including 28 of the Iguaninae species. Phylogenies generated from maximum likelihood analysis of separate data sets result in congruent phylogenies with varying levels of resolution. Results are discussed in terms of the phylgeographic history of this subfamily, future direction for study, and conservation implications.

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The origins of a large-scale pattern of community structure in emydid turtle assemblages: Competition versus phylogenetic niche conservatism

Phylogenetic studies of community structure have often found that the failure of a lineage or lineages to disperse between regions can be related to geographic trends in community structure. However, such studies have often failed to explicitly consider the factors that prevent the key lineages from dispersing between regions. We consider a latitudinal trend in community structure in eastern North American that seems to be related to the failure of two lineages of semi-terrestrial emydine turtles to disperse into southern communities. We then examine the factors that might limit the southern distribution of these lineages. The two hypotheses that we focus on are competitive exclusion by southern emydid species, and phylogenetic niche conservatism (particularly phylogenetic inertia in environmental tolerances). The latter hypothesis is tested by using GIS niche modeling in a phylogenetic framework. The study fails to find support for the idea that the northern semi-terrestrial emydines have been competitively excluded from southern communities. Conversely, the hypothesis that phylogenetic inertia in environmental tolerances has limited the southward distribution of these species is strongly supported. This study demonstrates how using a GIS approach in a phylogenetic framework can illuminate the origins of broad patterns in the biogeography of lineages, which can in turn be related to geographic trends of community structure.

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Invasion genetics of the Ponto-Caspian neogobiin Gobiidae

Two species of Ponto-Caspian neogobiins, the round goby (*Apollonia* - formerly *Neogobius melanostomus*) and the freshwater tubenose goby *Proterorhinus semilunaris* (formerly *P. marmoratus*), invaded the North American Great Lakes in 1990 via ballast water. Those species, along with other neogobiins - notably the monkey A. (formerly *N.*) *fluviatilis*, racer *N. gymnotrachelus*, and bighead *N. kessleri* gobies - also have been highly invasive and successful in spreading throughout Eurasian freshwaters via canals and shipping. Here we compare and

contrast levels of genetic diversity and divergence in invasive versus native sites from neogobiins throughout their ranges using nuclear microsatellite DNA variation, as well as mitochondrial DNA sequences from the cytochrome b and COI genes. The null hypothesis is that genetic variability in invasive sites is predicted to be relatively low and relatively uniform in composition in comparison with native ranges, reflecting the likelihood of only a few individuals becoming established. Conversely, higher genetic diversity may provide raw material for a species' invasive and establishment success. Our results show that a surprisingly diverse number of haplotypes characterize invasive neogobiin populations from all Great Lakes sites and many Eurasian locations analyzed, showing little or no founder effect in comparison with native populations. Additionally, results reveal significant differences among Great Lakes locations, suggesting that multiple founding sources and introduction events were involved. Also, the North American Great Lakes show regional distinctiveness in genotypes of the invasions, indicating considerable genetic structure. This high genetic variation likely led to the tremendous invasive success of the round goby in the Great Lakes. In addition, some genotypes already in the Great Lakes are also common in the Black Sea, suggesting that the round goby will likely become established in estuarine habitats along North American coasts - given transport and the opportunity. Such comparisons may allow us to predict the likely success of other invasive neogobiins in new habitats.

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Comparative broad to fine-scale genetic patterning in smallmouth bass and walleye across the Great Lakes and beyond

Population genetic structure of walleye *Sander vitreus* and smallmouth bass *Micropterus dolomieu* are compared in order to evaluate historical and behavioral events that shaped their phylogeographic patterns. These species have very different ecological and behavioral repertoires but share similar distributions that center on the Great Lakes, indicating a possible common vicariant history. In addition, understanding their demographic and habitat structure is essential for successful fisheries management and conservation of genetic diversity. Allelic length variation of ten microsatellite loci for walleye and eight loci for smallmouth bass are analyzed for evidence of broad to fine-scale population structure among spawning locations throughout the Laurentian Great Lakes and outlying populations. Results reveal that walleye have moderate to high levels of genetic diversity within spawning groups, whereas smallmouth bass display more moderate genetic variation but greater divergences among locations (about twice those of walleye). Evidence for both species suggests relatively high levels of fidelity among spawning groups, as well as pronounced divergences among lake and river populations. Both species show distinct genetic breaks between

the upper and lower Great Lakes, with primary barriers at Lake St. Clair, the upper Mississippi River System, the Ohio River system, and Lake Ontario. At fine scales, they display similar patterns with marked divergences among sites in eastern Lake Erie, as well as marked differences between the eastern and western basin locations. Smallmouth bass show evidence for isolation-by-geographic distance (as measured by shortest waterway connections) that is absent in walleye. Results from both species thus reflect their different ecologies and behavior, and support evidence for natal site fidelity. These patterns appear to have been present since the early formation of the Great Lakes. Conservation strategies should focus on maintaining these fine and broadscale genetic patterns.

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Satellite tagging of pelagic sharks off eastern Australia

The movements and behaviour of pelagic sharks were studied using direct satellite tracking tags and pop-off archival transponding tags (PSATs) deployed off the central east coast of Australia from commercial longline vessels. Eight blue sharks were tagged with direct satellite tags, mostly Wildlife Computers SPOT or SPLASH tags, and five blue sharks were tagged with PSATs. One each of shortfin mako, common thresher and bigeye thresher were tagged with PSATs. Tracks from SPOT tags were up to 137 days duration. One blue shark double tagged with a SPOT and PSAT died soon after release, and two others only transmitted for 6 and 11 days. The PSATs collected data for up to 180 days and there was evidence that some tags were bitten off, presumably by other sharks. Blue sharks remained in the general Australasian region for the duration of the tracks and those fitted with direct satellite tags transmitted nearly every day. Regions of high residency where the sharks were clearly not in transit were identified from the tracking data. The physical and biological characteristics of these areas were obtained from remote sensing data and we attempted to identify regions of local productivity that cause aggregation of blue sharks and to characterize their biotic and abiotic features. The PSAT data from blue sharks showed they usually spent 20-30% of their time in the 0-10 m depth strata, with about 5% of their time spent down to 600 m depth and with some dives deeper than 600 m. Most time was spent in the 17.5-20.0 degrees temperature range. The PSAT data from the other pelagic sharks also showed time spent at depth down to about 600 m but the thresher sharks, particularly the bigeye thresher spent less time at or near the surface.

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The skates of Alaska: Distribution, abundance, and taxonomic progress

Historically, skate populations in the eastern North Pacific and Bering Sea have been inadequately studied and inaccurately represented because of incomplete taxonomic knowledge and difficulties in obtaining accurate species identifications. As a result of collaborative efforts among many taxonomists and fisheries biologists, recent NMFS bottom trawl survey data reflect great improvements in the reliability of skate identifications, and have been instrumental in the description of new taxa. A data set compiled from the catch records of bottom trawl surveys from 1999-2005, including the Gulf of Alaska, Aleutian Islands, and eastern Bering Sea, gives a comprehensive overview of the skate fauna of Alaska. This data set includes a total of 14 recognized species of skates and at least one undescribed form, all of which are documented by photographs and represented by voucher specimens deposited at the University of Washington Fish Collection, as well as other collections around the country. With these reliable species-level identifications, the distinct species assemblages associated with each geographical and bathymetric region of Alaska have been identified, and patterns of overall skate diversity and abundance in the eastern North Pacific and Bering Sea are beginning to emerge. Moreover, catch data from NMFS bottom trawl surveys are being used to evaluate new sources of skate distribution data, including species-specific catch data now being collected by North Pacific groundfish observers

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Fishes of Georgia atlas project

Although Georgia is ranked among the top five U.S. states in richness of freshwater fishes, no comprehensive distributional atlas is available to document this fauna. Detailed distributional data is necessary for environmental review and conservation assessments, and is a great aid to the accurate identification of fishes. We are developing an online atlas of Georgia's freshwater fishes. The atlas will include small watershed (HUC 12) distribution maps and a photograph for each of the approximately 290 fishes that regularly or occasionally occur within the freshwaters of the state. Primary sources of fish distribution records will include The Georgia Museum of Natural History, The Georgia Dept. of Natural Resources, regional and national museum collections, unpublished research findings and primary literature. A large component of this project will involve pulling these records into a single database and verifying questionable records. To date, our database includes 6645 collection records from 3705 unique localities (sites). Sample sites are clustered in North and SW Georgia, and we plan to make additional collections in under-sampled areas during summer 2006. The database includes records for approximately 287 recognized native and 11 introduced species. Only four described species are truly endemic to the state, but many other described and undescribed species have a large proportion of their range in Georgia. Approximately one-third of the fauna is considered imperiled, and at least 6 species may be extirpated. Our poster will include sample maps, sample photos, and a preliminary list of Georgia fishes by major basin.

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Control and containment options for a Georgia population of Asian swamp eels (*Monopterus* sp. cf. *M. albus*)

The Asian swamp eel is an exotic, invasive species that has been introduced in the southeastern U.S. on at least four occasions. Populations are known from

Florida (Homestead, North Miami, and Tampa), and Atlanta, Georgia. The Atlanta population was introduced into at least one pond at the Chattahoochee Nature Center (CNC) in the early 1990s. The CNC has direct outflow connections to the Chattahoochee River through an adjacent marsh. Therefore, recent studies have focused on control and containment options for this population. Swamp eels are obligate air-breathers, protogynous hermaphrodites, and can travel over land and live in a variety of habitats, making them excellent invaders. Swamp eels have been discovered in marsh areas of the Chattahoochee River adjacent to the CNC, although to date, no eels have been found upstream or further downstream. These marshy areas are inundated during high flows and are included in the downstream flow of the river. We studied the biology and ecology of this population and investigated physical and chemical methods for removal and/or eradication. Eels are actively reproducing in three CNC ponds and possibly in the marsh. Diet appears to consist mostly of invertebrates but does include some fish (including other swamp eels). Physical removal methods included electrofishing for adults and sub-adults and leaf-litter traps for juveniles. Laboratory studies on effectiveness of antimycin suggest that removal using this chemical is not a viable option, as swamp eels appear resistant. An integrated approach of containment and control involving physical removal and restructuring pond outflows appears to be the best current management plan for addressing this particular population of exotic invaders.

***STREICHER, JEFFREY W.; EDWARDS, CODY W.**

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Genetic variation among members of the *Craugastor* (*Eleutherodactylus*) *podiciferus* species complex

The Neotropical anuran genus *Eleutherodactylus* represents the largest extant vertebrate genus with over 700 described species. Despite this diversity, little is known regarding the evolutionary relationships among many of the more ubiquitous members of the genus. The *Craugastor* (*Eleutherodactylus*) *podiciferus* complex represents a group of polymorphic direct-developing frogs that inhabit the highlands of Costa Rica and Panama. This putative species is considered common from 1100-2600m and is found in this elevational band of suitable habitat throughout the Cordilleras de Tilarán, Central and Talamanca. Its unique distribution presents several interesting questions concerning the initial dispersal and present day gene flow of the species, given the extensive geographic barriers that separate many of the populations. The complex is presumed to contain multiple taxa, but difficulties in identification and the previous consideration of small sample sizes have hindered the recognition of unique species within this group of anurans. The present research aims to elucidate divisions within this complex via the use of molecular markers and extensive sampling from localities throughout the range of *C. podiciferus*. Through the examination of nucleotide

sequence divergence, the genetic dynamics of both disjunct populations and the species as a whole are tested. Because the IUCN lists this species as vulnerable, there exists an urgent need for the clarification of specific boundaries in order to formulate more appropriate conservation measures for the complex.

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Evaluation of neodymium-iron-boride magnets on demersal longlines

The U.S. Atlantic pelagic longline fishery primarily targets Swordfish (*Xiphias gladius*), Yellowfin Tuna (*Thunnus albacares*), and Bigeye tuna (*Thunnus obesus*) in various areas and seasons. Secondary target species include Dolphin (*Coryphaena hippurus*), Albacore Tuna (*Thunnus alalunga*), as well as several species of pelagic sharks and several species of large coastal sharks. Although some sharks such as the Shortfin Mako (*Isurus oxyrinchus*) are a commercially valuable secondary species, many non-commercially valuable sharks are captured as bycatch during pelagic longline fishing. Such bycatch has several negative impacts including but not limited to: (1) removal of ecologically important species with no little commercial value, (2) reduction of fishing efficiency aimed at target species by reducing the number of hooks available to target species while occupying hooks, (3) reduction of fishing profits associated with commercial fishing through increased gear costs associated with lost hooks gear resulting damage by sharks. In an experiment to reduce these impacts, neodymium-iron-boride magnets were deployed on demersal longlines at South Bimini, Bahamas. The magnets used in this evaluation did not produce aversive behavior in captive Yellowfin Tuna and Cobia (*Rachycentron canadum*). The localized magnetic field permits a single demersal line to have both controls and treatments. This line consisted of fifteen gangions with 16/0 steel circle hooks and hook event timers. Seven gangions on this line were fitted with magnets. All hooks received the same type of bait, were rebaited at the same time of day, and were monitored at 4 hour intervals for shark catch. During two sets, we report fewer sharks were caught on magnetic treatment gangions when compared to control gangions. In a separate observation, we report that two tiger sharks (*Galeocerdo cuvier*) were captured within the same three hour period when undersized magnetics were used. A third tiger shark was also captured on a control gangion within the same period.

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Evaluation of Semiochemical Shark Repellents on Demersal Longlines
International concerns have been raised about apparent population declines of large pelagic fishes including predatory sharks that are ecologically and

commercially important. A major contributor to the international population decline of large pelagic predatory sharks is commercial pelagic longline fishing targeting tuna and swordfish (Falterman & Graves 2002; Peel et. al. 2003; Uozumi 2003; Kerstetter 2004). Beerkircher et. al. (2002) suggests that Carcharhinid sharks comprise the largest portion of shark bycatch during U.S. commercial pelagic longline fishing with blue sharks, *Prionace glauca*, comprising the greatest biomass of any bycatch species. As a potential means to reduce this shark bycatch, we have evaluated semiochemical shark repellents at South Bimini, Bahamas using demersal longlines. The semiochemicals used in this evaluation study did not produce aversive behavior in captive Yellowfin tuna, (*Thunnus albacares*) and Cobia, (*Rachycentron canadum*). Five demersal lines were set, with three lines dedicated as controls. Each line consisted of fifteen gangions equipped with 16/0 steel circle hooks and hook event timers. Adequate spacing between control and treatment sets was allowed to reduce the effects of chemical plumes. All hooks received the same type of bait, were rebaited at the same time of day, and were monitored at four hour intervals for shark catch. Results demonstrated significantly lower shark catches on treatment lines as compared to the control lines.

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Phylogeography of the Flathead Chub (*Platygobio gracilis*) based on ND4, ND5 and Cyt b sequences

Platygobio gracilis is composed of two subspecies, *Platygobio gracilis gracilis* and *Platygobio gracilis gulonella*, that are currently distinguished using morphological criteria. It's distribution stretches from northern New Mexico and Texas, north to British Columbia and Alberta, Canada with a large zone of hypothesized intergradation that stretches throughout most of the Missouri River drainage. Cytochrome B (cyt b) (1140 bp), ND4 and ND5 (3903 bp) mitochondrial genes were sequenced and aligned for 30 individuals of flathead chub from throughout this range, along with seven outgroup taxa. Phylogenetic and phylogeographic analyses of these data sets (cyt b and ND4/ND5) failed to produce any significant structure either within or between the subspecies of this taxon. In fact most individuals failed to group by either geographic location or existing subspecific taxonomy with any partition or combination of these data. The results of this study along with implications for the management of this species will be presented and discussed.

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Dispersal and demographics of the American Bullfrog in arid valley habitats

Intentionally introduced into the western U.S., the American Bullfrog (*Rana catesbeiana*) has negatively affected native aquatic amphibian and reptile populations throughout the region. In 1999, we drained ponds and successfully removed bullfrog populations from most of Buenos Aires National Wildlife Refuge, Pima County, Arizona. Over the subsequent 9 weeks, we found migrating bullfrogs at these and other ponds and pools up to 11 km from presumed off-refuge emigration sources. In 2000, 2002, 2003, and 2004 we cohort-marked bullfrogs at the presumed sources, and kept refuge ponds free of bullfrogs by collecting any that arrived. In dry summers (2000, 2002, and 2004), we recovered marked bullfrogs at 3.2 and 6.4 km dispersal distances, and found no bullfrogs farther into the refuge. During a wet summer (2003), we confirmed marked frogs at 9.6 km and presumed migrants were seen >11 km from known source populations. At two normally dry sites ca. 3-4 km from sources, immigrants grew so rapidly, that, two months after pond filling, the site ostensibly resembled an established, breeding population. In 2003 and 2004, using program Remark, we estimated bullfrog population sizes in five ponds and Arivaca Lake. Population sizes ranged from 21 in a new perennial pond to 6045 in an established perennial pond (stock tank). There were an estimated 4435 frogs in Arivaca Lake, a decades-long established population. Our data suggest that bullfrog removals must occur on a landscape scale (>10-km radius) if they are to succeed. Caution must be exercised in evaluating bullfrog population status using visual surveys, as some transient populations can appear to be established and reproductive, based on different size classes of frogs observed.

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From histology to hormones: Advances in the study of skate reproductive biology and the potential use in conservation management

Information regarding sexual maturity and reproductive cycles in skates has largely been based on gross morphological changes. For example, past studies have used structural endpoints, such as clasper length in males, ovary weight in females, or gonadosomatic index (GSI), to help assess reproductive status in these species. In contrast, few studies have used histological changes or circulating steroid hormone concentrations as endpoints to establish when skates

become reproductively capable or to determine reproductive cyclicity. The present study summarizes our current knowledge of histological and hormonal analyses in skate reproduction. This study also offers information that analysis of circulating steroid hormone concentrations, as a conservation management tool, may provide a means to determine size at sexual maturity and to assess reproductive cycles without the need to sacrifice the animal.

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Reproductive cycle of the blacknose shark, *Carcharhinus acronotus*, in the Gulf of Mexico

The reproductive periodicity of blacknose sharks, *Carcharhinus acronotus*, in the northern Gulf of Mexico was determined by examining reproductive tissues from specimens collected monthly from 2002 through 2005. Monthly changes in shell gland weight, right ovary weight and ovarian follicle diameter were assessed for 74 mature females. Temporal changes in testes weight, testes width and percent of mature spermatocysts were examined for 64 mature males. Trends in female reproductive tissues suggested an annual peak in reproductive activity during June and July, while trends in male parameters suggested an annual reproductive peak during May and June. Although male and female reproductive activity peaked in different months, a strong synchronicity existed between the percent of mature spermatocysts and the diameter of the largest ovarian follicle. Based on these results, the mating season of blacknose sharks lasts from mid May to July in the Gulf of Mexico. Maximum embryo sizes were observed in May which suggested that partition occurs during late May or early June. Results indicate that blacknose sharks have a clearly defined annual cycle in the Gulf of Mexico. This conclusion is further supported by the complete absence of gravid females without vitellogenic ovarian follicles among all mature females examined.

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Herp conservation hotspots: Delineating the highest priority sites for amphibian and reptile conservation

Reptiles and amphibians do not often receive as much attention as birds or rare plants when public or private land conservation groups set priorities for future projects. At least part of the reason for this discrepancy is the lack of conveniently packaged information on the current distribution of rare herp populations. When faced with a similar difficulty, the ornithological community had the foresight to establish a system for designating Important Bird Areas (IBA), which are defined as localities of high value to preserving bird biodiversity. I propose that US herpetologists design a similar system for

identifying and delineating Herp Conservation Hotspots for each state. Canadian herpetologists have already implemented a plan for describing Important Amphibian and Reptile Areas (IMPARA). However, the Canadian IMPARA system and the original IBA regime will both end up including substantial fractions of already protected parks, preserves, and wildlife refuges in their portfolios. I suggest it may be more useful for the herpetological community to focus our energies on identifying those unprotected privately owned sites which are of highest priority for amphibian and reptile conservation activities. Groups or individuals designating lists of Herp Conservation Hotspots would certainly need to use caution in order to avoid either alienating landowners already friendly to conservation, or attracting the attention of unscrupulous collectors to the rare herps found on these sites. If such pitfalls can be avoided through careful design, I believe a Herp Conservation Hotspot designation-system for private lands would prove very useful for enhancing the protection of habitat for declining reptile and amphibian populations.

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The use of trained dogs to detect rare native snakes

Herpetologists often have a difficult time locating many species of snakes in the field, due to the cryptic nature of these secretive reptiles. Although there are several relatively productive techniques available for catching snakes, such as road-cruising, funnel traps with drift fences, and artificial cover items, all of these methods have their respective flaws. Many snake researchers have long wished for some kind of magic snake-finding device that would enable the efficient, reliable capture of their target snake species. Trained snake-detecting dogs might provide this magic solution. With their superior olfactory abilities, dogs have proven capable of locating many other kinds of wildlife, and potentially may be able to track down numerous snakes that human searchers would be unable to find. In order to test the hypothesis that dogs can be used to find wild upland snakes, I began training a pair of snake-detecting dogs in 2003. After two years of training, one of the dogs achieved a small measure of success in 2005, finding three species of native snakes, including the rare northern pine snake and southern hognose. In my presentation I will describe the methods I have used for training dogs to find snakes, and offer generous suggestions for alternate training techniques that may prove even more successful for other researchers. I will also provide the results of formal testing of the dogs' snake-detection capabilities (scheduled for completion May 2006). After discussing my own work I will briefly review the status of other snake-detecting dog projects that are now underway in other parts of the world, and conclude with a preliminary evaluation of the utility of this approach for finding snakes.

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Survivorship estimates of three life stages of the Houston Toad (*Bufo houstonensis*)

Although the Houston Toad has been endangered for over three decades, few data have been collected regarding the population dynamics of the species. From 2001 – 2005, an extensive study focusing on all life stages of the Houston toad was conducted at the Griffith League Ranch (GLR) located in Bastrop County, Texas. Egg strand numbers were estimated using 4 techniques. A set of concentric drift fences with pitfalls were placed around *B. houstonensis* egg strings in 2002 and 2003 and 657 post-metamorphic juveniles were captured, marked, and monitored for 13 weeks. Survivorship from egg to metamorph was estimated to be 0.473 and 0.4 from metamorph to 13 weeks. A linear regression predicted survival through adulthood for these cohorts to be 0.0002. Drift fences and pitfall traps along with breeding pond surveys were used to capture adult Houston toads. During the study, 194 adult *B. houstonensis* (168 M : 26 F) were captured and marked with PIT tags. Sampling effort remained constant among years, yet toad captures declined. A Cormack-Jolly-Seber mark recapture model was fitted to the data along with a model without time-specific survival probabilities. A likelihood ratio test determined no significant difference between the models ($= 0.05$, $2 = 4.21$). Yearly adult survivorship during the study period was estimated to be 0.24.

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Effects of castration on body fat, growth rate, and home range size in free-ranging male rattlesnakes

Testosterone levels in male rattlesnakes are generally very high during mating seasons, and may be one physiological mechanism responsible for sex differences in body size and composition. In many animal species, testosterone promotes somatic growth and lipolysis while inhibiting lipogenesis. Also, male rattlesnakes often exhibit larger home range sizes than females, especially during the mating seasons, which may result from high testosterone levels in mate-searching males. We captured 14 male Western Diamond-backed rattlesnakes (*Crotalus atrox*) at a field site in central Arizona in spring 2003. We castrated seven of the snakes, performed sham surgeries on the other seven, and

monitored them with radiotelemetry for two years. We collected blood samples and measured the body mass and SVL of the snakes several times during the experiment. At the end of the experiment, snakes were collected and sacrificed. Abdominal fat pads and the fat-free carcasses were weighed. We estimated the total and active season home range size of each snake using minimum convex polygon and fixed kernel methods. We found that castration did not affect growth rate, suggesting that testosterone may not be the primary physiological factor governing male-larger sexual dimorphism in rattlesnakes. However, castrated males had significantly higher wet fat mass and percent body fat than sham males. Increase in body fat is a common effect of castration in males of many animal species, and may result directly from the decrease in levels of testosterone or indirectly via behavioral changes due to castration. A surprising result was that castrated males had much larger home range sizes than sham males (2-3 times larger, depending on the method used). These results must be interpreted with caution because measurement of testosterone levels in blood samples showed that testosterone levels were reduced but not eliminated in castrated males.

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Integration of historic and recent data for population dynamics modeling of spiny dogfish in the Northeast Pacific

The spiny dogfish, *Squalus acanthias*, has a long history of exploitation in the Northeast Pacific. Landings rose to a peak of over 50,000 mt in 1944 but have remained below 10,000 mt since 1950. Fishery statistics, biological data, and dorsal spines for ageing were collected in the 1940s and a tagging study was conducted. Information for the recent decades includes the same data types with the addition of bycatch data from observer programs and abundance indices from surveys and fisheries in the US and Canada. This paper describes an age-structured metapopulation model which integrates the historical data with the more recent sources. The metapopulation framework allows the modeling of declining abundance indices in inside waters of the Puget Sound along with stable indices in coastal waters. Uncertainty in the estimate of current depletion is discussed, and the implications for conservation and management of this long-lived, late-maturing species are considered. The use of alternative measures of population status, including reproductive value, is proposed.

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Genetic variation in color vision proteins corresponds with microhabitat in the Neotropical goby genus *Elacatinus*

One of the largest genera of Caribbean fishes is the goby genus *Elacatinus*, which occupy a diverse array of reef microhabitats. Despite the ecological differences, many species are characterized by a brightly colored lateral stripe. The most common lateral stripe color is yellow, which is the likely ancestral state, with subsequent changes to blue or white. Lateral stripe color differs between sister taxa, which suggests that coloration may function as a mate recognition cue. Recognition of potential mates could be visually enhanced by "spectral tuning" of the opsin proteins responsible for color vision. Spectral tuning, the replacement of key amino acids residues in the protein, alters the wavelength absorbed by opsins in an additive, predictable manner. To determine whether spectral tuning corresponded to lateral stripe coloration in *Elacatinus*, I sequenced rhodopsin, and short and medium wavelength opsins, from more than 30 taxa. For a few taxa, either rhodopsin or short wavelength opsin were found to evolve under positive selection acting on tuning sites. However, spectral tuning did not correspond to lateral stripe coloration; instead, genetic variation corresponded to microhabitat differences between taxa. This result suggests that spectral tuning may enhance visual acuity associated with the ecological niches occupied by different species of *Elacatinus*.

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Gobioid molecular systematics: A look back and a long view

With more than 2000 species, many of which are reduced and/or simplified morphologically, the perciform suborder Gobioidae has long been considered a challenging group for systematists. Since the last gobioid symposium in New Orleans in 1996, the use of DNA sequence data for gobioid systematics has increased dramatically, resulting in new hypotheses of relationships for all gobioid groups. One prominent conclusion from studies of molecular phylogeny is that the more speciose gobioid groups (Eleotridae and Gobiidae) are paraphyletic with respect to the smaller gobioid families (Xenisthmidae, Microdesmidae, Ptereleotridae, Kraemeriidae and Schindleriidae). I review the various hypotheses of gobioid interrelationships based on morphology and DNA sequence, and present a new overall phylogeny for Gobioidae, including consideration of outgroup relationships.

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Population structure of Pacific *Gnatholepis* species inferred from microsatellites

Individuals of two closely related species of goby, genus *Gnatholepis*, were sampled across the South Pacific and screened for eight microsatellite loci to determine the level of genetic structuring among the populations. The two species differ ecologically, with *G. anjerensis* inhabiting shallow lagoons while *G. scapulostigma* primarily occupies deeper water habitat outside of lagoons. A prior study using mitochondrial genes failed to illuminate a great degree of population structuring among *G. scapulostigma* and only slightly more structure among *G. anjerensis*. However, analysis of microsatellite loci for these species has proven to elucidate population differentiation greater than that detected with mtDNA sequence. A considerably greater amount of structuring among populations of *G. anjerensis* than *G. scapulostigma* was revealed, although distinct populations of *G. scapulostigma* are now evident. This discrepancy may be attributed to their differing habitat preference. Both species experienced population expansion in the Pleistocene, and it is postulated that the greater degree of structuring found in *G. anjerensis* populations is associated with habitat loss due to fluctuations in sea level.

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A test of vicariant patterns in southeastern Australia in multiple sympatric *Hypseleotris* species

A key tenet of vicariance biogeography is that species with similar distributions should show congruent biogeographic patterns. Here we test this hypothesis in southeastern Australia in the genus *Hypseleotris* with a phylogenetic analysis using cytochrome *b* for 179 individuals from five species. Three or four *Hypseleotris* species are usually sympatric within each of three biogeographic provinces: Eastern (EP), Murray-Darling (MDP) and Central Australian (CAP). At many localities it is possible to collect all three or four species within the same seine hauls. Each species has broad environmental and physiological preferences which allows them to be abundant and broadly distributed. Phylogenetic analysis resolves the five species into four major groups: two clades of *H. klunzingeri*, one consisting of individuals from EP, plus two northern MDP localities, and the other including the remainder of MDP localities, along with CAP individuals. The other two clades include a mixed *H. galii*/*H. sp. 3* Murray-Darling clade, with EP and MDP lineages mostly segregated and differentiations in populations spread along EP, and a mixed *H. sp. 4* Lake's and *H. sp. 5* Midgley's clade, with a more mixed phylogenetic distribution of geographic localities. Additionally, three *H. sp. 3* Murray-Darling individuals fall outside their primary grouping, indicating the possibility of mitochondrial introgression among species, and/or retained ancestral polymorphisms in some *H. sp. 3* Murray-Darling populations. The overall picture demonstrates that despite their common distributions, each species has its own unique biogeographic pattern, suggesting that the causes of biogeographic movement within each species did not effect each species equally. Alternatively, it may also be possible that each species undertook similar movements, but there was uneven persistence of their genotypes.

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A world-wide generic revision of the family Aulopidae (Aulopiformes, Synodontidae)

This family has long been considered to consist of a single genus, *Aulopus*, even though Starks (1924) erected *Hime* for the widespread Pacific species *japonica*. Also generally ignored is Whitley's 1931 name *Latropiscis*, erected for *Aulopus*

milesii (=purpurissatus). Examination of considerable new material has resulted in the following generic classification for the family: 1) *Latropiscis*, monotypic for the Australian endemic *purpurissatus*, 2) *Hime*, six Indo-Pacific species, 3) *Aulopus*, two Atlantic species and two Pacific species, and 4) new genus, two Pacific species. Distinguishing characters for this classification include: fin ray, vertebrae and scale counts, pyloric caeca presence, size, and number, body and fin proportions, fin placement, fin ray filamentation, sexual dimorphism and body color, and cephalic pore system development.

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A new species of flagfin from Australia and New Zealand with comments on the genus *Hime* (Aulopiformes, Aulopidae)

The family Aulopidae is widespread in both the Atlantic and Pacific, found primarily on shelf and slope habitats. Although all species are often considered to belong to a single genus, *Aulopus*, there remains disagreement over generic placement of certain species. In addition, as more materials have become available for examination, we conclude that the family is more speciose than presented in most literature. We recognize a new species from northern New Zealand waters and some seamounts of the Tasman Sea, including Lord Howe Island, Australia. This form had been recognized as *japonica* in some references, but is quite distinct from 'true' *japonica*, differing in color pattern, and body and fin proportions. It also has more distinctive sexual dimorphism than *japonica*. We place this species in the genus *Hime* along with selected Indo-Pacific forms. We distinguish *Hime* from other genera of the family by a combination of meristics (fin rays, vertebrae, pyloric caeca), body morphology (fin positions, head proportions) and development of the cephalic pore system.

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Phylogenetic utility of 96 new nuclear DNA primers across the turtle tree of life

Phylogenetic utility of 96 new nuclear DNA primers across the turtle tree of life
Phylogenetically informative markers are often developed for a narrow set of

closely related species or populations. How well do the DNA primers developed for a single species maintain their phylogenetic utility for a broader set of taxa? To investigate this issue, we designed oligonucleotide pairs to prime 96 nuclear loci in the western painted turtle (*Chrysemys picta belli*) and tested them across a panel of turtles sampled from across the turtle tree of life. Primers were constructed by utilizing end sequences from a Bacterial Artificial Chromosome (BAC) library constructed from *C.p. belli*. These sequences were compared to existing GenBank sequences in order to gauge homology. Primer pairs were designed for 48 end sequences that showed high homology (e-value < 10⁻⁵) to GenBank sequence, and for 48 end sequences that showed little or no homology to GenBank sequences; the former are putative coding sequences, the latter are non-coding. All primer pairs were then tested across the selected panel of 25 phylogenetically representative turtle species by PCR. Primer pairs which reliably produced single PCR products were classified as 'working' and were mapped onto an existing turtle phylogeny in order to estimate the evolutionary time over which primer pairs work and to investigate the pattern of fall-off in overall number of working primer pairs. Limited sequencing was performed using working pairs in order to verify single copy status, assess broad phylogenetic utility by forming expectations of substitution rate, and directly test phylogenetic utility in a small clade of turtles. Additional possible applications of these primer pairs are also discussed.

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Observations of pedal luring in *Gastrotheca cornuta*

Many amphibian species are nocturnal, arboreal, fossorial or highly secretive, making the observation of behaviors such as courtship, breeding, intraspecific competition and prey acquisition very difficult. A digital video recorder and a camera with motion-sensitive and infrared capabilities were used to film the nocturnal activities of a captive group of horned marsupial frogs (*Gastrotheca cornuta*) over several weeks. The frogs were captured on film engaging in pedal luring on numerous occasions. After visually orienting toward potential prey (crickets), they began quickly undulating and vibrating the toes of their rear limbs in an apparent attempt to lure potential prey to a more proximal position. Although this behavior has previously been observed in species of several groups of frogs including *Ceratophrys* and *Phyllomedusa*, it has not been documented in *Gastrotheca*. Further use of this technology would enable more to be learned about the natural behaviors of these otherwise difficult to observe animals.

TIPTON, JASON A.

Aristotle's observations on the foraging interactions of the Red Mullet
(*Mullus surmuletus*)

Red and striped red mullets (*Mullus* spp), sometimes called goatfish, are famous food fishes in the Mediterranean, from ancient times up to the present. They are known as goatfish because of the two stout barbels they possess under their chins, which give them a goat-like beard; in fact, Pliny says that these mullets are distinguished by a double beard on the lower lip (Natural History, Book IX, 30). Pliny also identifies several varieties of the red mullet as some of the best food fish and even describes some of the sauces the epicureans of the day recommended with its consumption (Book IX, 30). Seneca (Ep. 95) tells of a large mullet given to the emperor, Tiburius. While they are renowned for the table, Aristotle makes no mention of this fact in his observations of the red mullet (trigla; in Attic Greek) in his History of Animals (HA). Among other things, Aristotle discusses the fact that the red mullet has a diet consisting of seaweed and shellfish (HA 591b12), occurs in lagoons (598a20), and describes some characteristics of its spawning (543a5, 570b25). Most remarkably, Aristotle also describes its interactions with another fish, the sargue or bream: The sargue or sargos identified by Aristotle is most likely a sea-bream of the Sparidae family, most likely one or more of the *Diplodus* spp, e.g. *Diplodus vulgaris*, *D. sargos*, *D. annularis*. The remarkable accuracy of Aristotle's observations of the co-foraging of *Mullus* spp. with breams will be discussed in light of field observations in Lesvos, Greece, the location where most of Aristotle's work in zoology took place, carried out in 2005.

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Movements of adult, metamorphic, and translocated metamorphic tiger salamanders on Long Island

Understanding the characteristics of ponds and vernal pools utilized by amphibians, as well as the upland habitats used throughout the year, is essential to the conservation and proper management of these species. The long-term survival of the New York State endangered Eastern Tiger Salamander (*Ambystoma tigrinum tigrinum*) is of special concern due to rapid development of its last remaining habitats on Long Island. A radio-telemetric study is currently underway at the Brookhaven National Laboratory on Long Island, New York. Data were collected from 2004 to 2006 at four pond locations. Twenty-three adults and thirty-three metamorphs have thus far been captured and implanted

with transmitters. Adult animals spent an average of 47 days and metamorphs 23 days in burrows between surface movements. Single night movements ranged from 7 to 237 m for adults and from 4 to 269 m for metamorphs. Implanted animals have been lost due to predation, loss of transmitter signal, or are still being tracked. Ten of the metamorphs were translocated 1500 m from one breeding pond to another, but none survived beyond 93 days. Single night movements for these metamorphs ranged from 5 to 289 m, with individuals moving in random directions from the release point. Based on our findings, we feel that the current 100-foot buffer zone for wetlands and aquatic breeding habitats and the corridors to maintain connections with adjacent areas beyond 500 feet are insufficient to maintain breeding populations of Tiger salamanders in NYS, nor does it appear that metamorphs can be successfully transplanted as a management technique.

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It's raining caudates and frogs: ontogenetic and interspecific variation in migratory responses to climatic factors among pond-breeding amphibians

Many pond-breeding amphibians from temperate regions undertake overland migrations to reproduce in aquatic habitats. In turn, their offspring metamorphose and emigrate to upland, terrestrial habitats. The phenology of these migrations has been documented for many species and in many regions of North America. Similarly, the migratory responses of amphibians to climatic factors have been studied extensively. However, timing of migration varies among species, among years, and with latitude within a single species. Thus, in order to compare among-species variability in migratory responses to climatic factors, several species must be examined contemporaneously at a single geographic location. We examined the diel patterns and daily variability of migratory movements of adult and juvenile amphibians in response to climatic cues at an isolated wetland in South Carolina, USA. Of the eight species we observed, *Ambystoma talpoideum*, *A. tigrinum*, *Bufo terrestris*, *Hyla gratiosa*, *Pseudacris crucifer*, *P. ornata*, *Rana sphenoccephala*, and *Scaphiopus holbrookii*, all migrated almost exclusively at night with the exception of recently metamorphosed *B. terrestris*, which frequently migrated diurnally (> 50% of captures). Additionally, we correlated daily captures of adult and juvenile *A. talpoideum*, *A. tigrinum*, *B. terrestris*, and *R. sphenoccephala* to maximum and minimum daily temperature, number of previous days without rain, total rainfall in the previous 24 hours, and interactions of these variables. Rain was often the most important predictor of amphibian captures. However, species differed in their response to climatic factors and rain explained little of the observed variance in captures of *B. terrestris*. We suggest that variation in the risk of desiccation and predation among species likely contributes to observed migratory patterns. Changes in regional weather patterns may have important

species-specific consequences for amphibians that rely on suitable climatic conditions to successfully complete their breeding and juvenile migrations.

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Convergence of calls of two toads in areas of sympatry

When two closely related species have overlapping ranges, females may have difficulty discriminating between conspecific and heterospecific signals, particularly if conspecifics and heterospecifics produce similar signals. There are three hypotheses for how the calls of a given species should differ between allopatric and sympatric populations: (1) calls of the two species may be more different when sympatric because costly heterospecific matings favor reproductive character displacement; (2) calls of the two species may be more similar when sympatric because of hybridization; and (3) calls of the two species may not differ between sympatric and allopatric populations because the two species do not interact. Molecular studies have found that hybridization occurs between *Bufo americanus* and *B. woodhousii* where their ranges overlap. Males from allopatric and sympatric populations of both species were recorded to determine how calls differed between allopatric and sympatric populations. It was found that the calls of *B. americanus* and *B. woodhousii* converge in areas of co-occurrence. Within each species, most call characters examined differed between allopatric and sympatric populations, and the calls of the two species were more similar in sympatry than in allopatry. The converging values for the calls in the sympatric populations suggest either the presence of numerous hybrids with intermediate call types and/or extensive bidirectional introgression. It is unclear if females are making mistakes in mate choice by choosing heterospecific males or if females are unable to make a choice due to scramble competition among males. Further study into this system must be done to determine the causes and nature of hybridization.

***TORAL, EDUARDO; FRENKEL CATY**

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Population state of *Atelopus exiguus* in the South Ecuadorian Andes

Amphibian decline is reported in tropical and temperate zones, including different altitudes. In Ecuador, these declines are reported since late 80 and early 90. Around 25 species of anurans have declined, being *Atelopus* one of the genus more affected. Of the 18 known species for the country, 11 have declined in the last 15 years, as is the case of *Atelopus exiguus*. Along with *A. mucubajensis* from Venezuela, *A. exiguus* is the only high altitud species of this genus that still remain in natural environments. *A. exiguus* is endemic of the South Occidental

mountain range of Ecuador. It inhabits the paramo and subparamo and is associated to rivers and creeks where they were very common. During the 80 the population start to decline and since 1995 no individual was observed until september 2004, were few individuals have been reported. Our study is determining the state of the population of *A. exiguus* in the Mazan Forest. 29 individuals are observed until now, 19 adults (one gravid female) and 10 juveniles. Neither eggs or larvae have been observed. All the individuals were found exclusively at the Mazan Forest, suggesting that this is the only location where they inhabit now.

TORKI, FARHANG

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A new species of Genus *Eirenis* (Serpentes: Coluberidae) from Zagros Mountains, Lorestan Province, Iran

A new species of coluber snake of genus *Eirenis* is described from the Sepidkoh region in Zagros Mountains, between Khorramabad and Kohdasht, Lorestan Province, western Iran, elevation 1350 m. The new species differs from its known Iranian congeners with 17 midbody scale rows in having more than 250 ventrals, square loreal scale, without any pattern on neck, head and body. Notes on ecology and distribution, of the new species and key to the Iranian species of genus *Eirenis* is provided.

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Morphometric analysis of the Atlantic species of *Bollmannia* (Teleostei: Gobiidae)

The genus *Bollmannia* Jordan is composed of fourteen nominal species, five from the Atlantic Ocean. The original description of *B. litura* is inconsistent with the meristics of the holotype, mainly in the counts of the second dorsal and anal fin elements. The original description of this specie was previously used to differentiate this specie from *B. communis*, *B. eigenmanni*, *B. boqueronensis* and *B. jeannae*, but the meristics of the actual holotypes show overlapping between these species. These discrepancies have led to the American Fisheries Society invalidating *B. jeannae* and *B. litura* as unique species in the 6th Edition of Common and Scientific Names of Fishes, where as Fishbase invalidates only *B. jeannae* and the California Academy of Science, Catalog of Fishes, still recognize both *B. litura* and *B. jeannae* as valid. In this study, we used morphometric analysis to determine if anatomical differences exist between *B. communis*, *B.*

eigenmanni, *B. litura*, *B. jeannae* and *B. boqueronensis*, which would allow us to reconcile the species status. Through the use of TPSdig software, we were able to place digital landmarks on photographs of cataloged specimens of each species, as well as the respective holotypes to make accurate morphological measurements for the basis of comparison. The results of this experiment should provide the information necessary to resolve the status of the Atlantic species.

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Nest guarding and aggression in the Red-backed Salamander, *Plethodon cinereus*

A great deal is known about aggression during territoriality in *Plethodon cinereus*, however aggression during nest guarding is less well studied. Few studies have examined how variables such as clutch properties, sex of intruders, or body condition of the mother affect aggression during clutch defense. Parental care theory predicts that large broods, representing a sizable reproductive value, should elicit greater parental efforts than small broods. In addition, maternal aggression should be directed only at conspecifics that pose a threat, since *P. cinereus* is densely populated and accidental encounters occur frequently. Although female red-backed salamanders are known to cannibalize eggs, it is less clear whether males also cannibalize. Finally, mothers in good condition should be able to defend the nest more effectively than mothers in poor condition. Three hypotheses were tested: 1) females should be more aggressive when defending a nest containing a large number (10) of eggs than a nest with fewer (4) eggs; 2) females should be more aggressive when defending a nest against female conspecifics than against males; and 3) females in better body condition should be more aggressive during nest guarding than less fit females. No significant difference was found in defense of large vs. small broods, or against female vs. male intruders. No relationship was found between any measure of body condition and aggressive behavior, although there was a trend towards those in poor condition being more aggressive. However, brooding females were significantly more aggressive than non-brooding females (evidence of egg rather than nest-site fidelity); and also significantly more aggressive than female and male intruders. This study suggests that other factors such as hormones may determine the level of aggression in female red-backed salamanders during nest defense.

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Land use influences on survival of spadefoot metamorphs from playas in

the Southern Great Plains

Habitat fragmentation and degradation is a major threat to amphibian populations and this threat is prevalent across the Great Plains. Playa wetlands are the primary breeding sites of Southern High Plains (SHP) amphibians, and agricultural practices that dominate the landscape may exasperate stressors naturally experienced by these amphibians. Playa wetlands are ephemeral habitats that fill via stochastic precipitation events and amphibian breeding success depends in part on hydroperiod timing and duration. Cultivation increases sedimentation in playas, reducing their hydroperiod and possibly breeding success of amphibians. Additionally, agriculture can fragment the landscape, possibly causing inbreeding depression. Tilling the upland may also degrade estivation habitat. Spadefoot toads are often the most prolific breeders in playas employing an r-selected reproductive strategy, and their metamorphs are often the most abundant vertebrate on the landscape after emergence. Given the importance of metamorphs in recruitment into the breeding population and the possible threats of agriculture, we tested for differences in apparent survival between populations emerging from playas in cropland and grassland landscapes using Pollock's robust design. In 2003 and 2004, we chose 6 playas in cropland and 6 grassland landscapes that filled with water following spring thunderstorms. Because rate of first capture was very high and recapture rate very low, we could not use all 24 datasets to make comparisons between land uses. We found no differences in end of season apparent survival between populations from cropland and grassland playas. However, apparent survival was generally low and highly variable. Our study reveals current estimators for r-selected amphibians with a life history strategy of remaining above ground for a short time period are inadequate for obtaining accurate survival estimates.

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Evolution and biogeography of Andean lizards in the genus *Stenocercus* (Squamata: Iguania)

The South American iguanian lizard genus *Stenocercus* includes 58 species occurring mostly in the Andes and adjacent lowland areas from northern Venezuela and Colombia to central Argentina at elevations of 0–4000 m. Limited taxon or character sampling have characterized all previous phylogenetic analyses of *Stenocercus*, which has repeatedly been proposed as sister taxon to the *Tropidurus* Group. In this study, I use molecular and morphological data to (1) infer the phylogenetic relationships among most species of *Stenocercus*, (2) perform explicit statistical tests of previous phylogenetic hypotheses, and (3) infer the ancestral distribution of *Stenocercus*. Using parsimony and Bayesian analyses, monophyly of this genus is strongly supported with a dataset of 32

species of *Stenocercus*, 12 outgroup taxa, and 1641 bp of mtDNA. Molecular data also are used to analyze evolutionary relationships within *Stenocercus* with a Bayesian approach based on mixture models, which accommodate variability in the parameters of the rate matrix across sites. Morphological data were obtained from 55 species of *Stenocercus* and one outgroup taxon; polymorphic and continuous morphological characters were coded using step matrices with frequency parsimony, and gap-weighting methods, respectively. Parsimony and Bayesian analyses were performed with a combined dataset of 55 ingroup taxa, one outgroup taxon, and 1764 characters. All analyses support a basal split of *Stenocercus* into two clades. One of these clades is restricted to the central Andes except for a few species occurring in the northern Andes in Ecuador and Colombia. The second clade is more widespread and includes species occurring in the northern, central, and southern Andes, as well as species in the Amazon Basin and lowlands in southeastern South America. A dispersal-vicariance analysis (DIVA) suggests that the most recent common ancestor of species of *Stenocercus* occurred in the central Andes.

***TOUCHON, JUSTIN C.; WARKENTIN, KAREN M.**

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Long-term effects of short-term variation: how egg environment changes tadpole phenotype and survival

Hyla ebraccata is a neotropical leaf-breeding treefrog with terrestrial eggs and aquatic larvae. Embryonic development takes 3-4 days and depends on rainfall, which varies. Eggs rapidly desiccate, and eventually die, without rain. Clutches laid near the water's surface can also become submerged when large storms fill ponds (25% of clutches observed in 2005, N=100 clutches). *Hyla ebraccata* eggs therefore develop in one of three environments: rained upon, not rained upon, or underwater. We reared split *H. ebraccata* clutches under simulated heavy rain, no rain (but occasionally misted) and submerged underwater. The egg-stage environment affected development, hatching time and hatchling phenotype. Submergence and desiccation both increased embryo mortality 20% and submergence delayed hatching by 17%. Preliminary analyses indicate that hatchlings from submerged eggs were smaller and less developed. In the first three days post-hatching, 33% of hatchlings from submerged eggs died, while mortality in other treatments was negligible. To test the effect of egg-stage environment on larval phenotype and development, hatchlings from each egg treatment were reared until metamorphosis. We removed subsets every 10 days after all tadpoles finished hatching for morphometric analysis and 24h predation trials with libellulid dragonfly nymphs and belostomatid water bugs. Egg environment had a counter-intuitive effect on survival with predators after 10 days; tadpoles from submerged eggs had the highest survival and those from heavy rain had the lowest, regardless of predator. Despite this fitness effect, preliminary analyses indicate no morphological differences in tadpoles from

different egg environments at 10 days. At 20 and 30 days, egg environment no longer affected survival with predators. We previously documented that desiccation dramatically increases predation on *H. ebraccata* eggs. It is now clear that short term abiotic environmental variation affects not only egg survival, but alters hatching timing and has substantial effects on tadpole survival, phenotype and predator-prey interactions.

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Reproductive mode variation in a neotropical treefrog: the leaf-breeding *Hyla ebraccata* lays eggs in water

Many anurans make oviposition site choice decisions in order to avoid competition, parasites, or predation. However, these flexible oviposition strategies remain within the confines of a single reproductive mode (i.e. aquatic or terrestrial oviposition). There are currently no known cases of anurans using multiple reproductive modes. Last summer we discovered that *Hyla ebraccata*, a neotropical treefrog with terrestrial eggs and aquatic tadpoles, lays its eggs in the water at Quarry Pond in Gamboa, Panama. In extensive fieldwork at nearby ponds we have found only terrestrial *H. ebraccata* eggs. This species is abundant and conspicuous throughout Central America, yet its aquatic oviposition has never been described. Aquatic oviposition in *H. ebraccata* represents a reversion to a more primitive reproductive mode and alters the ecological and physiological environment for developing embryos. When *H. ebraccata* embryos develop underwater about 20% die, and the rest hatch later and less developed than terrestrial eggs, probably because of oxygen limitation. This, as well as aquatic egg predation, likely favors terrestrial oviposition. However, risk of desiccation selects against terrestrial oviposition. Terrestrial *H. ebraccata* clutches need rain to survive, although those laid in shade survive 23 hours longer without rain than clutches in sun. Desiccation also increases egg predation rates 6-fold over hydrated clutches. Quarry Pond differs from nearby ponds in that it lacks a forest canopy, so eggs are fully exposed to sun. It also has more abundant floating aquatic vegetation, which may alter selection on eggs in the water. We will present data from oviposition site choice tests and experiments measuring the adaptive value of aquatic versus terrestrial oviposition in ponds where *H. ebraccata* uses each strategy. The variation in oviposition site (between aquatic and terrestrial) documented here is previously unknown in anurans and offers a tremendous opportunity to study the evolution of reproductive modes.

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Age and growth of four skates commonly caught as by-catch in the southeast Australian fisheries

In Australia, skates (Rajidae) are a common by-catch/by product of both State and Commonwealth trawl and non-trawl fisheries. Three continental shelf species (*Dipturus* sp. A, *D. cerva* and *D. whitleyi*) and one continental slope species (*D. gudgeri*) were examined for annulus deposition in the vertebral centra and caudal thorns. The two largest bodied skates *D. gudgeri* (n=300) and *D. whitleyi* (n=73) showed the most promising band formations in both structures using two different methods: whole and sectioned vertebrae and whole and sectioned caudal thorns. Both *Dipturus* sp. A (n=437) and *D. cerva* (n=180) showed relatively clear annuli in vertebral sections. These were viewed with transmitted light using a dissecting microscope fitted with a ColourView digital camera by Soft Imaging System and processed with AnalySIS software. The periodicity of growth band deposition for *D. gudgeri* was verified using marginal increment analysis and the caudal thorns were used for comparative measures in both *D. gudgeri* and *D. whitleyi*. Estimates for male and female longevity of *D. gudgeri* are 20 and 21 years, respectively. Longevity estimates for male and female *D. whitleyi* are 13 and 18 years, respectively. The two smaller inshore skates have lower longevity. *Dipturus cerva* male and female longevity is estimated at 8 and 9 years, respectively. von Bertalanffy growth model (VBGM) parameters for *D. cerva* males were estimated as $K = 0.20$ and $L_{inf} = 73.35$ cm and females $K = 0.31$ and $L_{inf} = 73.35$ cm. Male and female longevity for *Dipturus* sp. A is estimated at 11 and 12 years, respectively. The Francis reparameterised VBGM equation was also used for comparison.

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Dietary habits and overlap in the rajid species in southeastern Australian waters

Dietary information on skates (Rajidae) is vital in determining their ecological role and trophic relationships within their local environment and for creating ecosystem models. In southeastern Australia, seven skate species (*Dipturus* sp. A, *D. sp.B*, *D. cerva*, *D. gudgeri*, *D. lemprieri*, *D. whitleyi* and *Pavoraja nitida*) were collected from commercial and recreational fishermen between 2002 and 2004. The aim of this study was to determine dietary overlap between the species and to examine the ontogenetic shifts in diet. All stomachs from dissected skate species were excised, contents weighed and preserved. All prey items were then

counted, weighed and identified to the lowest possible taxon. Each prey group was assigned an ecological group listing to identify whether a shift in diet from benthic to pelagic prey occurred with ontogeny, size and species. The Index of relative importance was used to characterise diet. Seasonal, sex, trophic levels and geographic variations were also examined. Ontogenetic changes in diet were evident, five species as juveniles fed primarily on caridea (shrimp: *Leptochela sydniensis*), as size and maturity increased the diet progressed to larger prey items of a wider variety of taxa. The smallest skate species *P. nitida* consumed caridea throughout ontogeny. *Dipturus gudgeri* and *D. sp. B* showed the highest percentage of empty stomachs, possibly due to the fishing method, bottom drop-lining. Caridea, brachyura (crabs), cephalopoda and osteichthyes (fish/eels) were of the most importance in the diet of *D. sp. A* and *D. whitleyi* at different stages of ontogeny. *Dipturus lemprieri* preyed primarily on crabs, and the diet of *D. cerva* and *P. nitida* consisted of substantial amounts of *L. sydniensis*. *Dipturus sp. B* fed primarily on crustaceans (spider crabs, goneplacid crabs and squat lobsters). *Dipturus gudgeri* ingested similar prey to *D. sp. B*, although osteichthyes were also a significant part of the diet.

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Morphological changes of the *transversospinalis* muscles in the precloacal region of squamates and implications for the cervico-dorsal boundary in snakes

Although the complete loss of the pectoral girdle obscures the distinction between cervical and trunk regions in snakes, snakes possess cranio-vertebral muscles that differentiate from the rest of the axial musculature in the anterior precloacal region and insert on the skull, indicating the presence of a myologically distinct "neck." In the present study, the morphology of the most medial group of the epaxial musculature, the *m. transversospinalis* group, was investigated in various squamates, with an emphasis on changes in lengths of muscle slips toward the cranio-vertebral boundary. In tetrapodal squamates such as *Varanus* and *Gekko*, lengths of slips of *m. semispinalis* remain almost constant from the anterior dorsal region to the cranio-vertebral boundary, while those of *m. spinalis* begin decreasing anteriorly at around the cervico-dorsal boundary. Similar changes were observed in snakes: while the first 20 slips of *m. semispinalis* do not show much change in length, the *m. spinalis* slips begin shortening in the most anterior precloacal region. For example, such shortening starts with the slips arising from the sixth and eighth precloacal vertebrae in *Ramphotyphlops* and *Anilius*, respectively. Compared to tetrapodal squamates, therefore, the cervico-dorsal boundary in snakes may be located around those levels, based on this myological characteristic. The neck lengths inferred on this basis are within

the range of those based on the posterior extent of *m. transversospinalis capitis* (a cranio-vertebral muscle belonging to the *m. transversospinalis* group), but are much shorter than those based on the subvertebral *m. rectus capitis anterior*, suggesting that patterning of the axial differentiation may be independently regulated in different muscle groups.

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Effects of forestry practices for red-cockaded woodpeckers on space use by gopher tortoises (*Gopherus polyphemus*)

The gopher tortoise (*Gopherus polyphemus*) occurs in the southeastern Coastal Plain and has experienced widespread decline due to habitat loss and other human impacts. Although the species is currently listed as federally threatened in only the western portion of its range, many biologists believe federal protection throughout its range is warranted. The largest remaining populations occur on private lands (e.g., commercial timber lands) and military installations. Proper forest management at these sites will be critical to the success of the species. The goal of our study was to determine the response of gopher tortoises to forestry management practices commonly implemented in the management of red-cockaded woodpeckers (RCWs; *Picoides borealis*). We monitored habitat use of individual tortoises by radio-tracking adult gopher tortoises at four study sites with different ownership and management scenarios: Ft. Gordon (military installation, winter burning), Savannah River Site (federal defense facility, winter burning, translocated population), Tillman Sand Ridge (state wildlife preserve, summer burning), and a private hunting preserve (no management). Fifty-nine tortoises (8-26 tortoises/site) were tracked 2-3 times/week for two years. Canopy cover, tree density, basal area, and herbaceous vegetation categories were used to characterize each study site overall. Similar data were collected at active burrows to compare "tortoise-selected" vs. "typically-available" habitat. Movement patterns, space use, site fidelity, and burrow use patterns of tortoises were compared among the four study sites in the context of observed habitat parameters. Although sites with different management prescriptions varied in habitat characteristics important to both RCWs and gopher tortoises, habitat characteristics at "tortoise-selected" sites (i.e., burrows) were remarkably similar across study sites. Management for RCWs generally support tortoise habitat needs, although the prescriptions may not be identical. Results will be used to develop recommendations for the management of both resident and translocated populations of gopher tortoises.

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Site fidelity, survivorship and growth of juvenile translocated gopher tortoises (*Gopherus polyphemus*)

Until relatively recently, translocation of rare, non-game species has generally been viewed with skepticism, especially for reptiles and amphibians. For gopher tortoises in particular, two of the major concerns that have been raised are that translocation: 1) is not a proven conservation tool for the species, and 2) can undermine land conservation efforts by offering developers an "easy way out." However, continued fragmentation and loss of upland habitat, coupled with an increased focus on rigorous translocation research and post-translocation monitoring, suggest that translocation may become an increasingly important management tool for populations of threatened species. We translocated a population of gopher tortoises (n=106; 35 hatchlings, 33 juveniles, 39 subadults/adults) to the Savannah River Site, Aiken Co., South Carolina in Fall 2001. Radio-telemetry data from this and other studies of translocated tortoises suggest that subadults have greater site fidelity than adults, but the response of juvenile tortoises is largely unknown. We periodically trapped juvenile tortoises during the first five years following translocation, resulting in more than 110 captures-recaptures of 40 juvenile founders and new recruits. Site fidelity, survivorship, and growth data of translocated juvenile tortoises will be presented and compared to the limited data available for natural populations. The feasibility and importance of including juvenile tortoises in translocation projects will be evaluated.

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Productivity comparison of young of the year opaleye (*Girella nigricans*) and their algal food source

Herbivorous fishes have a profound impact on marine plant communities. Opaleye (*Girella nigricans*) are one of the few temperate marine herbivorous fish occupying Southern California waters. Currently, little information regarding the productivity of opaleye is known. This study seeks to compare productivity estimates of opaleye and their algal food source in order to link primary and secondary energy transfer. Opaleye biomass and wet weight will be used to estimate productivity based on Ricker (1946) and Allen (1950) production models. Algae productivity will be estimated by measuring dry weights of algae grown on unglazed terra cotta tiles. Productivity estimates of opaleye will help

elucidate the importance of trophic energy transfer between a primary producer and consumer within Southern California algal communities.

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"Temporary" population structure and its importance for evolution of freshwater fishes: Examples from the American Southwest

Many evolutionary studies of fishes discount population structure that is unstable or "temporary" in time and space as being unimportant for determining genetic diversity in the long term. Examples of temporary population structure include aggregations of spawning adults and spatially or temporally distinct assemblages of larvae and juveniles. We propose that aggregation behaviors may strongly influence genetic diversity in freshwater fishes, even when aggregations are composed of random subsets of the overall population. Genetic effects could be especially pronounced in the larval phase when mortality is high and resources required for recruitment are patchy in time and space. To support our argument, we present genetic and ecological data for two endangered fishes of the American southwest: the Rio Grande silvery minnow, *Hybognathus amarus*; and the razorback sucker, *Xyrauchen texanus*. In both cases, genetic samples were taken at spatially distinct localities over a period of seven years. Aggregations were spatially and genetically distinct each year, but genetic identities of aggregations changed from year to year. In the Rio Grande silvery minnow, we concluded that differential mortality among larval aggregations increased variance in reproductive success among spawners thereby reducing overall genetic diversity in the species. Natural recruitment in the razorback sucker no longer occurs, but genetic diversity of the species is only maintained by collecting larvae from several spatially distinct localities as a source for repatriation into the wild. Taken together, these studies suggest that temporary aggregations can have profound influence on maintenance of genetic diversity in evolutionary time.

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Natural history and habitat use of the Plains Garter Snake (*Thamnophis radix*) in Alberta

Most of what is known about the ecology of northern garter snakes comes from studies of the common garter snake (*Thamnophis sirtalis*). At northern latitudes, these snakes often have a characteristic annual cycle that includes communal

over-wintering and long-distance migration between hibernacula and summer habitats. Other northern species of garter snakes have not been observed as frequently to engage in the same behaviours, suggesting either that they are understudied or that they use the landscape in different ways and therefore may have different habitat requirements. The western plains garter snake, *Thamnophis radix*, provides an opportunity to test the generality of this 'sirtalis model' of habitat use in garter snakes. The natural history and the habitat use of these snakes were studied at the northern limits of their distribution in central Alberta in 2005. Snakes were captured opportunistically and tracked using telemetry, and data were collected on population structure, food habits and habitat use. Snakes were captured most of the time in fields, even though field comprised only 15% of the available habitat. Snakes were also strongly associated with edge habitat between field and scrub vegetation. Five snakes were radio-tracked to individual holes in the ground for over-wintering sites, and no communal dens were identified. Average distance moved to den site was 600 m from release location. Additional data on the spatial relationships between summer and winter habitats will be collected in 2006 to complete the comparison with the *sirtalis* model.

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Bonnethead shark (*Sphyrna tiburo*) androgen receptor: cDNA cloning and tissue specific expression through the male reproductive cycle

Steroid hormones are essential for proper reproductive development in all vertebrates. Androgens are sex steroids secreted by the gonads that regulate virilization, spermatogenesis, and sexual behavior. These physiological actions require the binding of androgen to a specific receptor protein. Androgen receptors (AR) are ligand-activated transcription factors that bind to a specific nucleotide sequence of DNA and positively or negatively regulate transcription. An understanding of the distribution and levels of expression of the elasmobranch ARs on the cellular and tissue level demonstrates the pattern of responsiveness to the androgenic hormones. In this study, a fragment of the AR gene was cloned and sequenced from the bonnethead shark, *Sphyrna tiburo*, an elasmobranch species with a well-defined annual reproductive cycle. Acquiring this gene sequence facilitated the construction of species-specific AR polymerase chain reaction (PCR) primers and bonnethead AR mRNA probes that were used to screen reproductive tissues for evidence of AR gene expression using reverse transcription (RT)-PCR and in situ hybridization (ISH), respectively. The RT-PCR screens demonstrated AR gene expression in the testes, seminal vesicles, and epididymides of male bonnethead sharks. ISH results localized the AR expression to the interstitial cells of the testes and mature spermatozoa within the seminal vesicles and the testes. Immunocytochemical methods used to detect

the AR protein produced comparable results in the shark testes. These findings along with seasonal and ontogenetic differences in AR expression will be discussed. Knowledge of AR receptors in elasmobranch fishes, being the oldest living animals that possess an archetypical vertebrate pattern of reproductive endocrinology, may provide insight into the evolution of steroid receptors and nuclear receptors as a whole. Further, knowledge of steroid receptor function may enhance our understanding of the mechanisms behind endocrine disrupting chemicals in the environment.

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Twenty-one years of long-term nest monitoring (1985-2005) of the American alligator in Everglades National Park, Florida USA

Systematic Reconnaissance Flights (SRFs) have been used from 1985-2005 to monitor nesting effort and nesting success of the American alligator in Everglades National Park (ENP). In the 1970s, annual alligator nest mortality due to flooding was high (97%) in ENP. This was largely due to unseasonal water discharge into Shark River Slough, a region of abundant alligator nesting. Because Everglades restoration in South Florida will modify the quantity, quality, timing, distribution (QQTd) and flow of water on an ecosystem-wide scale it is vital to understand how alligator nesting effort and success relate to hydrologic conditions. SRFs, have been used as a tool to detect landscape-level changes in alligator nesting in response to hydrologic change. We used harmonic analysis to assess relationships among hydrological variables such as stage, discharge, and rainfall, with abundance, nest success, and flooding of alligator nests. A total of 1,173 nests were counted along 25 variable length line transects from 1985 to 2005. The number of nests varied annually, with 85 % of nests occurring in Shark River Slough (SRS). There was less nesting effort during drier years compared to wetter years. There was a positive linear relationship between mean annual water, total rainfall from January-June, and nesting effort. Nest flooding was related to amplitude of stage and annual periodicity. Years with wet dry seasons and little periodicity had none to little nest flooding. The greatest nest flooding and mortality (86%) recorded since 1985 occurred in 2005, this was due to both, Hurricanes Dennis and Katrina which produced large rainfall events over a short time period. These events raised the water stage

precipitously, flooding many nests. Because nest mortality due to flooding is relatively low in other parts of Florida (6-9%) and little periodicity results in low flooding mortality in the Everglades, this suggests that the seasonal amplitude in water levels of Shark Slough were historically more stable and not as great as they are now.

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Historical biogeographic patterns across multiple Australian freshwater fish groups

Freshwater aquatic systems are different biogeographically to other habitat types due to their different distribution and connectivity patterns. Because obligate freshwater aquatic organisms are only able to move via direct connections between habitats, drainage basins greatly limit opportunities for movement due to their isolated nature. Potential physical connectivity between drainage basins is largely limited to two factors: changes in sea level, which allow drainages to coalesce when sea level falls; and drainage rearrangements, which result in changed catchment boundaries. Three freshwater fish groups, *Craterocephalus*, *Melanotaenia* and *Nannoperca* were chosen for phylogeographic analysis based on their broad ranges, number of species, geographic overlap and to provide maximum coverage of Australia. When phylogenetic patterns for each fish group were combined, there was little congruence in their patterns of divergence across Australia despite a high degree of co-occurrence. Two factors are proposed to explain this result. The first is that dispersal across freshwater biogeographic barriers may be more common than previously thought. This is due to the widespread presence of low drainage divides which may allow fishes to move across catchment boundaries during high rainfall periods without drainage rearrangement. The second is that vicariance in freshwater systems does not appear to be a powerful structuring force. Although vicariant events are occurring on a regular basis, the fish fauna may not be equally affected by these events due to differences in ecology and climate. Over-arching biogeographic hypotheses are inadequate to explain the independent histories of each group. My research adds to the growing body of literature that suggests independent biogeographic patterns are common. Therefore, finding broader explanations for patterns may be the exception rather than the rule.

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Reproductive biology of *Pterapogon mirifica*, an Australian apogonid with direct development, sexual dichromatism and solitary behavior

Pterapogon mirifica is an apogonid restricted to the western coast of Australia. Before this study, nothing was known about any aspect of its natural history, including its reproductive habits. In addition, its taxonomic position is not clear; there seems to be enough evidence to support placing it back into its original genus, i. e., *Quinca*. After years of unsuccessful intents in obtaining live specimens, the author traveled to the North Cape area and collected 10 individuals to conduct reproductive studies. Under laboratory conditions *Pterapogon mirifica* showed very aggressive behavior towards other co-specifics, which was in accordance with its unexpected solitary behavior seen in the wild. As a result, artificial pair formation was challenging and required ample space. Courtship displays generally followed other apogonids behaviors with side by side trembling and the female being the most active. One of the most conspicuous behaviors was the striking dichromatism displayed by males, which were able to change their body coloration from a normal all black to white in a few seconds. Only males incubated the clutch, which consisted of between 90 and 200 eggs. Unlike other apogonids, the eggs were not held together by chorionic filaments, and the size ranged from about 3.2 to 4.3 mm in diameter. The embryos needed 18 days (26-27°C) to complete development, hatched as eleutheroembryos, and remained 4 days within the parent mouth until release as juveniles. Juveniles showed co-specific aggressive and territorial behavior few hours after being released. The embryologic development of *P. mirifica* is presented, and compared to that of *Pterapogon kauderni*, an endemic species from Indonesia. *Pterapogon mirifica* is the third apogonid in which direct development is reported. The presence of this highly unusual reproductive mechanism among coral reef teleosts might be useful to clarify the phylogenetic relationships within Apogonidae, still poorly understood.

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Toward the development of an assay to detect endocrine disruption in reptiles

Thyroid hormones (THs) play an important role in the development of the vertebrate nervous system and are important regulators of the vertebrate metabolism, particularly that of mammalian and avian species. However, it is not clear the physiological and endocrine relevance of these hormones in poikilothermic organisms. Various organochlorines that act as environmental pollutants, such as polychlorinated biphenyls and hexachlorobenzene, are known to alter the normal function of the hypothalamo-pituitary-thyroid (HPT) axis. These synthetic compounds have been shown to induce a decrease in circulating TH and a compensatory increase in TSH production in mammals. Thus, by affecting the physiology of the HPT axis these compounds have the

potential to alter developmental and cellular functions in vertebrates. To investigate the impact of these pollutants on the HPT axis of non-homeothermic vertebrates we have cloned the thyrotropin-releasing hormone (TSHb) full length cDNA from the freshwater turtle pituitary. TSH is thought to be one of the main regulators of the reptilian thyroid gland. The cloned TSH cDNA exhibits extensive sequence conservation relative to other vertebrate sequences. The elucidation of the TSH cDNA sequence will allow us to develop a real time PCR assay to evaluate the impact of environmental pollutants on the expression of the POMC gene at a high control level of the reptilian HPT axis. In addition, the clone will help us gain an improved understanding of the physiological role of THs in the turtle.

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Embryonic and hatchling metabolism of smooth softshell turtles (*Apalone mutica*)

Elevated metabolic rates of developing embryos and juvenile offspring are considered a result of the cost of growth. Cost of growth includes synthesis of new tissues and metabolism of remaining yolk. Embryonic metabolic rates also increase as a result of rising maintenance costs as embryos grow in size. Metabolic rates of Smooth Softshell Turtle (*Apalone mutica*) eggs and hatchlings were estimated by measuring CO₂ production via open-flow respirometry. Metabolic rates were measured prior to hatching, at hatching, and once every 10 days over a 30-day period after hatching. Repeated-measures analysis shows that *A. mutica* metabolic rates increased to a maximum at hatching, then decreased below pre-hatch levels approximately 30 days after hatching. All terrestrial and aquatic turtle species studied thus far exhibit pre-hatch peak metabolic rates. However, data presented here shows that *A. mutica* undergoes a different pattern of metabolic expenditure. Causes of taxonomic variation in the timing of peak metabolic expenditure in embryonic and hatchling vertebrates are not well understood. In birds, pre-hatch metabolic peaks occur in precocial species that are able to thermoregulate, walk, and feed themselves immediately after hatching. Post-hatch metabolic peaks occur in altricial species that are not able to thermoregulate until several days or weeks after hatching. In reptiles, a pre-hatch metabolic peak is hypothesized to maximize hatching synchrony in variable nest environments. Pre-hatch metabolic peaks also suggest that growth may slow, or that all yolk reserves may be metabolized prior to hatching. Metabolic peaks occurring at or after hatching are hypothesized to occur in species that incubate eggs in uniform nest environments, continue growth-related organization of tissues after hatching, or retain post-hatch yolk reserves that are metabolized with a cost similar to specific dynamic action (SDA).

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Antipredator adaptations for two color morphs of the Eastern Red-backed Salamander, *Plethodon cinereus*

Populations of Eastern Red-backed Salamanders, *Plethodon cinereus*, exhibit color polymorphism. Two color morphs are common: a striped phase that is characterized by a red dorsal stripe and a lead phase bearing a completely black dorsum. Color polymorphism in *Plethodon* is widespread and may result from genetic drift acting on isolated populations or it may be maintained by selection. A recent hypothesis attributes the maintenance of the polymorphism and the geographic distribution of the color morphs to selection on correlated characters, namely behavior and physiology. It is unclear, however, if differential predation plays a role in this system. A series of laboratory experiments and a field study were conducted to determine whether striped and lead phase salamanders exhibit different antipredator responses and if the forms are preyed upon differentially. To test the hypothesis that red-striped and lead phase color morphs have different skin secretions, we conducted a tongue flick experiment with a common snake predator, *Thamnophis sirtalis*. Snakes were able to distinguish between salamander treatments compared to controls, but were unable to distinguish between the secretions of the two color morphs of *P. cinereus*. In predation trials, the red-striped morph and lead morph responded differently to *T. sirtalis*. Compared to the lead morph, red-striped individuals spent significantly more time in ATR and tended to remain immobile whereas lead phase individuals were significantly more mobile, spending more time walking and in sustained escape than red-striped individuals. In the field, the proportion of red-striped salamanders with autotomized tails was lower than expected by chance while the number of lead phase salamanders with autotomized tails was higher than expected by chance. The results from this study demonstrate that striped and lead phase individuals of *P. cinereus* respond differently to snake predators; these differences may explain differential rates of predation observed between the two forms.

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Effects of forest clearcutting on spotted salamander migration and dispersal

For vernal-pool-breeding amphibians, conservation laws in eastern North American may be ineffective because the laws preserve the amphibians' wetland,

but not upland habitat; though the amphibians spend most of their lives in uplands surrounding their breeding pools. For one such species, spotted salamander (*Ambystoma maculatum*), inadequate understanding of upland habitat requirements, coupled with nocturnal and subterranean behavior, hinder improvement of conservation plans. Furthermore, though spotted salamander survival may depend on metapopulation maintenance, little is known about its inter-patch dispersal mechanisms. Upland buffer zones around vernal pools have been proposed as a management strategy for these amphibians. However, substantial validation of such buffer zones, in the form of experimental upland habitat disturbances, has yet to occur. Specifically, no studies have examined the immediate effects of clearcutting on spotted salamander migration and dispersal. In this study, we used clearcutting to experimentally manipulate upland buffer widths at eleven vernal pools. We then conducted intensive radio tracking, and mark recapture at pitfall traps, to observe effects of clearcutting on spotted salamander movement. Three pools were used as controls; while four pools had a 30-m buffer and four pools had a 100-m buffer, each encircled by a 100-m clearcut. A total of 40 salamanders (21 in 2004, 19 in 2005; 25 females, 15 males) were tracked for an average of 124 days (range: 6 to 270 days). Mean maximum migration for females was 120m (range: 1.6 to 405m), and for males was 83m (range: 3.9 to 288m). At the clearcut treatment pools, 20% of females and 29% of males successfully crossed the clearcut; and for about 30% of both sexes, their longest stay at a single location was in the clearcut (range of longest stay in clearcut: 30 to 121 days). Results from this study will be used to improve forestry Best Management Practices.

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The late-stage larvae of Caribbean gobies, eleotrids, and microdesmids: Identification guide and patterns of size and age at settlement

The late-stage larvae of most of the shallow-water genera of Caribbean gobioids are identified from collections in Panama. Most species occur in nearshore waters only at their specific settlement sizes and many specimens have begun transition in body form and markings. The range of settlement size within species is notably narrow; typically plus or minus one or two millimeters. The size and age at settlement vary greatly between species, encompassing much of the range exhibited by all reef fishes. Size at settlement for goby species ranges from around 5 mm SL in *Bathygobius curacao* to almost 30 mm SL for *Sicydium (antillarum)*, with most species settling around 6-10 mm SL. Pelagic larval durations for different gobioid species range from about two weeks to many months. I found notable variation in melanophore patterns within larval types as well as a remarkable range of morphologies and markings in larvae undergoing transition, making identifications from conventional keys and literature difficult. The number of photographs required to describe accurately this variation necessitates a web-based guide I have prepared at www.coralreeffish.com. In general, the transition from larval melanophore patterns to juvenile markings begins in a subset of individuals while larvae are still pelagic and continues into

the first few days after settlement, thus providing an invaluable missing link for larval identifications. Morphological changes in transitional larvae include marked changes in eye shape, head morphology, and the acquisition of complex patterns of head neuromasts. Most larvae were identified to species by meristics or transitional missing links, however for several genera with numerous similar species (*Lythrypnus spp.*, *Sicydium spp.*, and the cleaner gobies *Elacatinus spp.*), DNA sequence analysis studies are underway or planned.

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Actual status of NOM-029-PESC-2004

In 1997 initiated the workshops of the Technical Group to elaborate the NOM-029 project about the shark fishery regulation in Mexico. After several meetings, in January 12, 2000 this project was published for its public consultation. Nevertheless, due to diverse observations, the final version was not published. Subsequently, in July 12, 2002 was published practically the same version for its public consultation. The main objective of NOM-029 was regulate the shark fishery, but this version did not regulate the fishing areas, neither establish prohibitions, neither regulate the types of hooks and nets, neither establish limits to the incidental catches and neither limit the fishing effort. So, in base to a NOM-029 workshop called by three Commissions of the Senate, one of the Representatives Camera and the government of the state of Baja California Sur, the entrance in vigor of the NOM-029 was abrogated. From then a review process began by the Technical Group, there were carried out diverse workshops about the impact of the fishery on marine mammals and turtles, fishing gears, legislative aspects and shark population status. With the results of these workshops a new NOM-029 project was elaborated and sent to competent Mexican government instances. Nevertheless this project was rejected by pressure of the industrial fishery sector, since the project regulated the type and number of hooks and established prohibition areas for the big boats. It is urgent to regulate the shark fishery in Mexico, since their populations have diminished hardly affecting the fisheries in both oceans.

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Displacement of a toad species, *Bufo fowleri*, via larval competition with the invasive *B. nebulifer*

Fowler's toad (*Bufo fowleri*) was historically abundant and widespread in various habitats, including urban and agricultural areas, in southern Louisiana. Coincident with intense anthropogenic disturbance, the abundance of the Coastal Plain toad (*B. nebulifer*) has increased significantly in degraded habitats. Subsequently, *B. fowleri* is found only in forested areas near permanent water bodies that are not preferred breeding habitat of *B. nebulifer*. I hypothesized that larval competition with *B. nebulifer*, a species that breeds in extremely ephemeral habitat commonly found in disturbed areas, contributed to *B. fowleri*'s decline. I raised tadpoles in intra- and interspecific competition in artificial ponds under simulated permanent and temporary breeding habitat conditions. Six ponds contained a total of 140 *B. nebulifer* tadpoles per pond, six ponds contained a total of 140 *B. fowleri* tadpoles per pond, and six ponds contained 70 of both tadpole species, totaling 140 tadpoles. Competition with *B. nebulifer* tadpoles, but not pond drying, resulted in a decrease in body size measures and a lower rate of survival to metamorphosis for *B. fowleri* tadpoles. *B. nebulifer* tadpoles were slightly larger in drying than in permanent ponds, and were larger and had a higher rate of survival to metamorphosis in interspecific tanks than in intraspecific tanks, indicating that it is easier for *B. nebulifer* to outcompete congeners than conspecifics. At ephemeral breeding sites often found in disturbed habitat, *B. fowleri* tadpoles may be unable to compete for food resources with *B. nebulifer* tadpoles that are likely to be adapted to actively forage and swiftly metamorphose at a larger size. The Coastal Plain toad's superior competitive ability in temporary breeding sites may have resulted in ecological displacement and a decline of regionally sympatric populations of Fowler's toad in degraded landscapes.

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Impact of directional hybridization between two toad species (Genus: *Bufo*) on the decline of a parental species

Habitat disturbance leading to the breakdown of ecological barriers between sympatric species has resulted in hybridization between numerous plant and animal species, and often contributed to the decline or extinction of one or both parental species. Toads of the genus *Bufo* are known to hybridize where species ranges overlap, although differing habitat requirements generally function as an effective barrier to gene exchange. Despite strong postzygotic selection against it, hybridization occurs between two normally ecologically isolated species, *B. nebulifer* and *B. fowleri*, as a result of anthropogenic habitat alteration. This hybridization is potentially resulting in a decline of the rarer species, *B. fowleri*. Hybrids can be morphologically cryptic; therefore, molecular methods were used to identify them. Single nucleotide polymorphisms (SNPs) are a recent technique utilized to identify hybrids that cannot be conclusively identified by

morphological characteristics alone. Twelve species-specific SNPs from a 330 base pair fragment in a nuclear intron of the Rhodopsin gene were used to identify each species, and hybrids were identified based on heterozygosity at these sites. Eighty-one individuals from eight mixed breeding populations were directly sequenced and three male hybrids of *B. nebulifer* and *B. fowleri* were identified. The mating of a *B. nebulifer* male and a *B. fowleri* female produced two of the hybrids. The reciprocal cross, widely thought to be inviable, resulted in the other hybrid. Although hybrids represent a relatively low segment of the sample population, directional hybridization of male *B. nebulifer* with female *B. fowleri*, as demonstrated by previous research, may be a historical factor in the decline of *B. fowleri*. Furthermore, infertile male hybrids have been shown to preferentially mate with *B. fowleri* females, potentially causing a devastating loss of reproductive effort in females of that species.

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Satellite transmitters are tracking *Podocnemis expansa* to their non-nesting habitat in the Rio Trombetas, Brazil

Podocnemis expansa is listed as NR conservation dependent by the IUCN because of the continued effort Brazil has made towards the conservation of this species at the nesting beaches. This has worked in many areas where the nesting populations have increased or at least remained stable. This is not the case in the Trombetas River where populations have crashed from 8000 in 1976, to 850 in 1989, to less than 200 in 2003. IBAMA has requested that this population be listed as Critically Endangered because of the recent rapid decline. During 1989-1996 we were able to show through the use of VHF transmitters that the turtles nesting in the Trombetas Reserve leave the reserve after the nesting season, but we were not able to determine where they went. In November 2005 we attached both VHF and satellite transmitters to 10 post nesting females to determine where they migrate after the nesting season and to discover if the ships used in transporting bauxite may be frightening the turtles away from the river. In addition to this we want to find out where the turtles actually go when they leave the river and how long they remain in other habitats. The project is a success we are documenting the movements and microhabitat use by 9 of the tagged females. After 4 months the turtles are all still within the reserve, some have migrated 65 km downstream, others have taken up residence in the large lakes. Some have been found foraging in 1.5 m of water with temperatures of 43 C. Habitat use and home ranges as well as migration rates and distances will be presented. The limitations of satellite transmitters for tracking freshwater turtles will be discussed.

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The effect of toe-clipping on two species of treefrogs in Florida

Accurately estimating vital rates of populations is critical for management and conservation of amphibians. Estimation of survival requires unique marks for individuals, but efficient, low-cost marking methods for small treefrogs are limited to toe clipping. In the Everglades of southern Florida we marked green treefrogs (*Hyla cinerea*) and squirrel treefrogs (*Hyla squirella*) in unique toe-clip patterns of 2, 3, or 4 toes. Subsequently, we performed survival analyses on capture-recapture data using Cormack-Jolly-Seber open population models to estimate both apparent survival and recapture probability. Our objective was to determine if there was an effect of the number of toes removed on survival of individuals. There was a significant toe-clip group effect for green treefrogs. Individuals with 4 toes removed had a 7.2% lower average monthly survival compared to those with 2 toes removed, but there was no significant difference in survival between green treefrogs with 2 and 3 toes removed. Power analysis indicated that there was a 95.6% probability of detecting the 7.2% decrease in survival with the sample size of this study ($n=1296$), and 98.4% probability of detecting an average monthly decrease in survival of 10% per toe. No significant toe-clip effect was found for squirrel treefrogs. Power analysis indicated that it would require a four-fold increase in our sample size of squirrel treefrogs to detect a 5% decrease in average monthly survival per toe removed with a probability of 97.8%, but the sample size of the study ($n=712$) was adequate to detect a 10% decrease per toe. Other studies have found effects of 4-11% decrease in return rate per toe removed. Studies that use return rates to estimate survival assume that recapture rates are constant, but the best model of recapture probability for both species in this study allowed recapture probability to vary with time. We caution against an approach based on return rates alone.

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Is the Desert Tortoise of the Mojave Desert a keystone species in an old-growth ecosystem?

The concepts of keystone species and old-growth ecosystems have been widely used in the past few decades, so much so that a clear understanding of them has faded away. However, the management implications for both concepts are tremendous, thus an understanding of definitions is necessary. Keystone species are ones that play dominant roles in an ecosystem and affect many other organisms; they can be predators, herbivores, or habitat modifiers. However, the title *keystone species* in most cases does not apply to all members throughout the species range but rather its functional role in a particular community assemblage. Examples of keystone species include the ochre sea star, sea otters, beavers, and gopher tortoises. We will present a case study of the gopher tortoise as a keystone species and compare it to results from our research on desert tortoises. Old-growth is a definition that was developed for forested systems and as such is not traditionally applied to desert ecosystems. However, key features are present in all definitions of old-growth that can be applied to desert ecosystems. These include: large long-lived species, the tendency for dominant species to have complex crown structures, mixed aged stands, sensitivity to fire, and minimal signs of human disturbance. They also tend to provide habitat for plants and animal species that either do not occur in younger stands, or occur less abundantly. We will make a comparison of these old-growth features to creosote bush scrub. We will then present data from a study on microhabitat selection by the desert tortoise to show that they are highly selective of habitat, selecting large shrubs, primarily large creosote bush. Results from this research, although preliminary and from a localized area, support the statement that in the Mojave Desert the desert tortoise is a keystone species in an old-growth ecosystem.

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Habitat specificity and home-range size as attributes of species vulnerability to extinction: A case study using sympatric rattlesnakes

Ecologically similar, closely related, sympatric species can be used to test the role of ecological attributes in determining species vulnerability. Large home-range size and habitat specificity are two commonly cited ecological attributes that are believed to contribute to species vulnerability. The eastern diamondback rattlesnake (*Crotalus adamanteus*) is a declining species that occurs sympatrically

with the more abundant canebrake rattlesnake (*C. horridus*) in a portion of the southeastern Coastal Plain, USA. In this study, ecological similarities of the two species were used as experimental controls to test the role of home-range size and habitat specificity in the imperilment of the eastern diamondback rattlesnake. Analysis of variance was used to investigate differences in home-range size between the two species, and home range selection was modeled as habitat use versus availability with a case control sampling design using logistic regression. We failed to detect differences in home-range size between the two species; therefore, we could not identify home-range size as an attribute contributing to the imperilment of eastern diamondback rattlesnakes. However, eastern diamondback rattlesnakes selected pine savannas to a degree that suggests that the species is a habitat specialist. Of the two factors affecting species vulnerability, habitat specificity to the imperiled longleaf pine ecosystem may be a significant contributor to the decline of the eastern diamondback rattlesnake.

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Phenotypic distribution of *Nerodia erythrogaster* in extreme southern Illinois, western Kentucky, and adjacent western Tennessee (USA)

To investigate anecdotal range distributions for *Nerodia erythrogaster*, 130 adult specimens from southern Illinois, western Kentucky, and adjacent western Tennessee were scored for ventral color and dorsal pigment invasion onto the ventral scales. Analysis of these characters suggests that true *Nerodia erythrogaster flavigaster* populations do not occur in Kentucky and may be absent from Tennessee as well. The region is instead dominated by morphs intermediate between *Nerodia erythrogaster flavigaster* and *Nerodia erythrogaster neglecta*. Furthermore, the range of *Nerodia erythrogaster neglecta* should be extended along the Ohio and Cumberland Rivers.

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Relationship between anuran species richness and the composition of bottomland hardwood forests

Development of conservation strategies for pond-breeding amphibians relies on a fundamental understanding of the habitat and landscape-scale characteristics associated with populations. As part of USGS's Amphibian Research and Monitoring Initiative (ARMI), we monitored 40 roadside sites in the Atchafalaya Basin, Louisiana, for calling anurans and quantified the overstory vegetation adjacent to 19 of those sites. A total of 12 species of anurans varied in occupying from 26-100% of the sites. Stepwise multiple regression indicated that values of tree dominance have a significant positive relationship with overall anuran species richness. Hydroperiod has a strong influence on site occupancy by amphibians, and is also known to influence dominance in communities of overstory trees in floodplain areas. This relationship between hydroperiod and dominance explains, in part, the observed relationship between overstory dominance and anuran species richness. We suggest that estimates of dominance in the overstory vegetation may be a good surrogate for hydroperiod in situations in which direct measurement is not feasible. Our data suggest that heterogenous, mixed-species forests with low dominance promote the highest species richness of anuran amphibians. Thus, species' dominance is an important habitat variable to consider in designing management plans for amphibian populations.

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The role of individual variability on consumption rates of captive juvenile winter flounder, *Pseudopleuronectes americanus*

Details about the feeding of an organism may be critical to understanding its growth and survival. Although important, individual variation in consumption rates is often overlooked. We studied consumption rate in laboratory-reared juvenile winter flounder, *Pseudopleuronectes americanus*, by conducting a series of input-output trials using a range of sizes of recently settled winter flounder (7 to 30 mm TL). Individual winter flounder were introduced into a 14-cm diameter arena, offered a known number of *Artemia* nauplii (2.5 per ml), and allowed to feed for 2 hr. The number of live *Artemia* remaining after 2 hr were preserved and counted. The number of *Artemia* consumed by the flounder increased linearly with flounder body size, especially in smaller juveniles ($R^2 = 0.3$ for flounder < 16 mm TL). Above 16 mm TL, no significant relationship was found between the number of *Artemia* consumed and flounder size. We evaluated the intra-individual component of variability in number of *Artemia* consumed by running two trials on the same individuals over multiple days and found repeatability to be very high ($R^2 = 0.8$). We also repeated the 2-hr trials on a subset of individuals after 14 and 28 days. Repeatability remained high throughout these trials. Thus, variability in the number of *Artemia* consumed was partly due to flounder size for recently settled fish but the major portion of the

variation was due to individual differences other than body size. Moreover, individual consumption rates were directly related to growth rate in the short term. Although the source(s) of differences in consumption rates among individuals is unknown, and the environmental conditions in these trials did not vary, the high level of intra-individual repeatability means that individual fish feed at a consistent rate, and that these rates are predictive of growth and perhaps survival.

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Population responses of wood frog (*Rana sylvatica*) tadpoles to overwintered bullfrog (*R. catesbeiana*) tadpoles

In temperate latitudes, the larval stage of bullfrogs typically lasts two years to complete metamorphosis. As such, ephemeral ponds in these latitudes are not suitable breeding sites for bullfrogs. Other amphibian species having shorter larval periods might breed successfully in both permanent and ephemeral ponds. Larvae in ephemeral ponds, therefore, experience a different community structure than those larvae of the same species in permanent ponds where bullfrogs might also be present. We examined the population responses of sympatric wood frogs tadpoles to native overwintered bullfrog tadpoles. The presence of an overwintered bullfrog tadpole had a negative effect on the growth of wood frog tadpoles allotopic (naïve) to bullfrogs, whereas the presence of bullfrogs had no effect on growth of syntopic (experienced) wood frog tadpoles. There were also differential behavioral responses of the wood frog populations to overwintered bullfrog tadpole visual and chemical cues. Only allotopic wood frog tadpoles decreased activity levels and increased use of refugia in the presence of overwintered bullfrog tadpoles. These observations indicate that overwintered bullfrog tadpoles might exert a selective pressure on other sympatric amphibians, and that bullfrog establishment within its native range might have negative consequences on larval dynamics of other amphibian species.

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Passive acoustic evaluation of red tide effects on sand seatrout spawning

Sand seatrout, *Cynoscion arenarius*, is an estuarine sciaenid with a protracted summer spawning season generally beginning in March and ending in late

October. Mature male sand seatrout generate courtship calls in the crepuscular and evening periods during the spawning season. Underwater microphones, or hydrophones, can be used to detect these courtship calls and locate spawning sites. During the 2004 and 2005 sand seatrout spawning seasons a mobile hydrophone survey was conducted in Tampa Bay to assess the frequency and location of sand seatrout spawning aggregations. Sampling stations were selected in the lower and middle portions of Tampa Bay using a stratified random sampling design with sampling occurring between April-October in both 2004 and 2005. During 2004, 610 stations were sampled with sand seatrout spawning occurring at 44% of stations. Aggregations were consistently detected during the 2004 season with no significant monthly variation. Aggregation detection drastically declined in 2005 to only 28% of stations (n=624) containing aggregations. Monthly detection of aggregations varied significantly during the 2005 spawning season with a pronounced decline after June. The annual variation in spawning between 2004 and 2005 as well as the monthly variations observed in 2005 are likely attributable to a large and persistent red tide bloom (*Karenia brevis*) that inhabited the Tampa Bay area. Although the bloom began in spring 2005, middle and lower Tampa Bay experienced elevated cell counts as well as massive fish mortalities starting in late June and continuing throughout the summer, paralleling the decline in sand seatrout spawning. Typically, red tide effects on finfish are limited to observing and counting mortalities. However, this two year study comparing a normal spawning season to a season where spawning habitat health has been compromised demonstrates how passive acoustics may be used as an additional tool to evaluate red tide impacts on a fishery.

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**Using remote sensing and geographic information science to predict
habitat for the Bog Turtle, (*Glyptemys muhlenbergii*)**

The southern population of the bog turtle, (*Glyptemys muhlenbergii*), was listed with the US Fish and Wildlife Service as "threatened due to similarity of appearance" in 1997. Status surveys are on-going for the southern population, yet the current methodology for locating new populations is labor intensive and fiscally exhaustive. Remote sensing offers the opportunity to use known parameters to discover additional habitats that are similar in biological composition and environmental conditions. Using multispectral bands, a "fingerprint" of the exact biological and environmental assemblages can be used to find other habitat areas that have the same fingerprint. Furthermore, remotely sensed imagery and associated data can be read and interpreted in the convenience of an office, reserving field investigation time and financial resources for sites that have a high predictive success rate. The purpose of this paper was to determine whether publicly available data, in the form of satellite

imagery and digital aerial photographs, could be analyzed to identify additional or potential bog turtle wetland habitat sites. A subset of a Landsat 7 ETM+ image and digital color infrared aerial photographs were used for a portion of Ashe County, North Carolina where the wetlands occurred. The results of this study indicate that publicly available data may not be suitable for detecting small, isolated wetlands across the landscape due to heterogeneous landscape features, low spatial resolution of the images, and inherent poor quality of some of the images. However, in some areas the digital imagery was of high quality, high spectral/temporal resolution, making it possible to define spectral signatures for these wetlands. These GISc technologies can be calibrated for specific criteria and used for other turtle species, thereby enhancing conservation resources, reducing investigative field search efforts and affording turtle species the protection required to assist in their future survival.

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Salamanders in forest-floor food webs: Plethodontid salamanders exert strong influence on invertebrate species composition

Terrestrial salamanders are hypothesized to play an important role in the regulation of forest-floor invertebrate communities of temperate North America, but few studies have quantified these effects experimentally. We investigated the role of the red-backed salamander, *Plethodon cinereus*, within forest-floor food webs using field experiments with both open-plot and enclosure designs. The objectives of this work were to characterize the importance of salamanders for shaping species composition of forest-floor communities, and to identify the principal taxa and trophic channels influenced by salamanders. During a long-term field experiment in open-plots, salamanders have been associated with significant reductions in density (>30%) of major mesofaunal taxa, e.g., Collembola and Acari, in comparison to habitat patches unoccupied by salamanders, and the magnitude of mesofaunal suppression increased with salamander density within plots. However, the strength of salamander effects is greatest during periods with high leaf-litter thickness and favorable salamander foraging conditions. Salamanders have had no effect on the density of macrofauna, e.g., spiders, centipedes, beetles, ants, etc. A short-term study within field enclosures also indicated that salamanders suppressed mesofauna, but not macrofauna, and that the negative effect of salamander predation on mesofauna was greater than the effect of large competitors, i.e., isopods, of mesofaunal detritivores. These results suggest that *P. cinereus* exerts top-down effects principally through mesofaunal trophic channels, and that the strength of these effects can be similar to or greater than that of other forces shaping mesofaunal communities (e.g., competition).

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Patterning of the abdominal viscera in Polypteriformes

Highly elongate body forms have evolved multiple times independently within Actinopterygii. Axial elongation in ray-finned fishes occurs via the addition of abdominal vertebrae, the addition of caudal vertebrae, or through a lengthening of the vertebral centra. *Erpetoichthys calabaricus*, a member of Polypteriformes, has twice as many abdominal vertebrae as its sister genus, *Polypterus*. Most work on anterior-posterior patterning has focused on the vertebral column. In this study, we examined anterior-posterior patterning of the viscera in *Polypterus senegalensis*, *Polypterus palmas*, and *Erpetoichthys calabaricus*. We recorded the anterior and posterior positions of individual visceral organs relative to both percent total length and vertebral number to determine whether the organs were relatively longer and covered more segments, or whether the organs were patterned differently in *Polypterus* and *Erpetoichthys*. In addition, we examined whether there were differences between males and females within the same species. We found that abdominal elongation involves both lengthening of some organs, as well as changes in the segmental positions of others. The results of this study provide a basic understanding of the anterior-posterior patterning of the viscera in Polypteriformes, and how changes occur when the number of abdominal segments is increased. In the future this work will be extended to investigate the visceral topography of other abdominally-elongate lineages of vertebrates.

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Prey selection in early life stages of *Semotilus Atromaculatus* (Creek Chub) in a small Ohio stream

In most ecosystems fish species switch their diet as they undergo development from larval to juvenile stages. During the course of development the ability to ingest a larger prey item could be due to morphological changes, such as the gape size, ossification of cranial elements, fin development or greater functionality of the sensory system. Past studies of feeding behavior have focused on European cyprinids, while North American cyprinids have not been studied extensively. In this study, feeding behavior of larvae through early juvenile stages of *Semotilus atromaculatus* was examined. Fish were collected from Doan Brook, an urbanized stream located in Cuyahoga County, Ohio. Doan Brook has a very limited food base consisting largely of chironomids. The gut

contents of 132 specimens were analyzed and prey items measured. Chironomids appeared in the gut of early larvae and continued to be the main food source with increased size. It appears that fish around 9.7mm standard length switch to significantly larger sizes of chironomids. Another switch to even larger sizes of chironomids appeared around 14.8mm standard length. Using ANOVA, there was a significant difference in size of the largest chironomids ingested among fish of different sizes. The degree of cranial ossification and fin development were further examined using 25 cleared and double stained specimens to determine if, in fact, there exists a correlation between these factors and shift in prey item size. Ossification is nearly complete in key cranial bones, the maxilla, premaxilla, dentary, pharyngeal arch, and opercle, near 9.7mm standard length, the size where fish are able to utilize larger prey. Fin development appears to correlate to some degree with the switch in prey item size. The results suggest that ossification of cranial elements along with fin development plays an important role in prey capture of larval fish.

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**Decline in yellow stingray (*Urobatus jamaicensis*) in the Florida Keys
National Marine Sanctuary, USA**

The 'common' elasmobranch species *Urobatus jamaicensis* (yellow stingray) has undergone a steady decline in the Florida Keys National Marine Sanctuary (FKNMS), USA. The yellow stingray is one of the smallest and most common elasmobranch species in the Caribbean. It is considered a good tropical fish for personal/commercial aquariums and is often used for scientific experiments. Currently, no permit is required for extracting *U. jamaicensis*, and only sold extractions are reported. This study analyzed temporal trends and environmental preferences of the yellow stingray in the FKNMS as recorded by trained volunteer divers using the Roving Diver Technique. Data were obtained from Reef Environmental Education Foundation (REEF) Fish Survey Project. Experienced divers in the FKNMS were interviewed about their impression of the yellow stingray to determine if the decline was detected. Included in this study were 10 different habitat types, depths from 0-37 m, and surface temperatures from 15-35°C. A generalized linear model on presence-absence data with a binomial distribution and logit link was used to estimate the change in *U. jamaicensis* by year. Habitat type, depth, site, average temperature, and Julian date were included in the model to standardize the data. A total of 15639 surveys conducted at 388 sites throughout the FKNMS were used. *U. jamaicensis* was seen on 2502 dives in FKNMS (16%). The decline in sighting frequency has occurred in all habitat types, depths, sites, and regions of the FKNMS. *U. jamaicensis* sightings declined from 32.1% SF (425 sightings in 1326 surveys) in

1994 to 8.5% SF (93 sightings in 1093 surveys) in 2005, averaging <18% decline per year. Preliminary analysis indicates that the decline in yellow stingrays is consistent in other areas of the Caribbean. The decline has gone virtually unnoticed. This study highlights the importance and use of trained volunteer divers for monitoring elasmobranchs.

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Timing of vibration-cued hatching in red-eyed treefrogs: How much information is enough to assess predation risk?

The arboreal eggs of red-eyed treefrogs, *Agalychnis callidryas*, hatch rapidly and up to 30% early in attacks by egg-eating snakes and wasps. They escape by falling into the water, where they face new predators; thus when to hatch is a behavioral decision balancing two risks. Physical disturbance of the clutch plays a key role in predator-induced hatching and, in playback experiments, vibrational cues from snakes are sufficient to induce hatching. However, egg clutches are also subject to vibrations from benign sources. Embryos should not, and do not, hatch in response to all vibrational disturbances. Embryos use both frequency characteristics and temporal pattern (duration and spacing) of vibrations in their hatching decision. Assessing temporal pattern requires a period of sampling and, since neither benign natural disturbances nor predator attacks are stereotyped signals, several cycles may be necessary to distinguish between them. We used playback experiments to examine the time course of hatching in response to synthetic vibration stimuli that elicited similar overall levels of hatching and were matched for duty cycle, but varied in cycle length (1.1-11 sec). The mean onset of hatching varied from 25 to 75 sec into the playback across stimuli. Embryos started hatching sooner, and the peak of hatching was earlier, in response to stimuli with shorter cycles. However, embryos sampled fewer cycles of long-cycle stimuli before initiating hatching, compared with short-cycle stimuli (range 7-23 cycles). Information, and thus certainty about the level of risk, should accumulate with cycles of the vibrational pattern. In contrast actual risk, or the cost of gathering information, accrues as eggs are consumed over time. The variation in the amount of information required to initiate hatching in response to different patterns of disturbance may reflect a trade-off between the value of additional information and the cost of information acquisition.

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Habitat use and reproduction of the Desert Massasauga Rattlesnake in Colorado

The Massasauga Rattlesnake is a diminutive species with a distribution in the United States which largely tracks the retreat of Pleistocene glaciation and the spread of grasslands. It is found in a variety of habitats, including arid grasslands in Colorado. We have monitored several metapopulations of Desert Massasaugas (*Sistrurus catenatus edwardsii*) in Colorado over the last ten years and have conducted radiotelemetry on one population in SE Colorado. Massasaugas were most active between 14 and 30 C, with an average ambient temperature during activity of 22 C. In the spring, snakes make long distance movements (up to 2 km) from the hibernaculum (shortgrass, compacted clay soils) to summer foraging areas (mixed grass/sandsage, sand hills). Summer activity is characterized by short distance movements, and snakes are most often observed at the base of sandsage in ambush or resting coils. Snakes showed a seasonally-dependent shift from primarily crepuscular/diurnal to nocturnal movement patterns. Massasaugas in Colorado gave birth to five-seven young in late August, and reproduction appears to be biennial. Observations on three radioed gravid females suggested that Desert Massasaugas show maternal attendance until the first neonatal shed. Snakes returned to the hibernaculum area in October and appear to hibernate individually in rodent burrows; however, the immediate region is utilized by several other species of snakes, particularly Prairie Rattlesnakes (*Crotalus viridis viridis*), and we believe this area is exceptionally important as a winter refuge for numerous snake species. Population size of *S. c. edwardsii* in Colorado appears to be quite large based on total number of captures and low recapture rates. At present, the main metapopulations occur far from developing regions in the state, and they appear to be stable. However, due to habitat loss and fragmentation resulting from agricultural expansion and urbanization, these populations will become increasingly threatened in the future.

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A re-examination of diversity patterns of South American herpetofaunas using multivariate statistical approaches

We studied patterns of species richness and composition of the herpetofauna at 67 sites representing seven biogeographic regions in South America: Amazonia, Atlantic Forest, Caatinga, Cerrado, Chaco, Guayana, and the Llanos. We

acquired the most data for frogs and snakes, so we used those taxa to make comparisons between taxonomic groups and across regions. Alpha diversity of frogs was highest in Amazonia, followed by Guayana and the Atlantic Forest. Snake richness was highest in Guayana, and slightly lower in the Cerrado and Amazon. Across all sites, alpha diversity of frogs and snakes was correlated, but this was not the case within any of the biogeographic regions. Analysis of species composition revealed that most of the biogeographic regions included were faunistically distinct, but snake species composition did not differ between Chaco and Cerrado or Amazonia and Guayana. Compositional dissimilarity among regions was greater for frogs than for snakes, a pattern likely attributable to the observation that snakes occupy a greater fraction of available sites than frogs. The correlation between compositional similarity and geographic distance (a metric of beta diversity) was stronger for frogs than for snakes, though it is not clear if this represents biological reality or sampling bias. Species composition was least correlated with distance in Atlantic Forest, indicating particularly high levels of beta diversity in that region. We modeled species richness as a function of five variables: annual rainfall, distance of a site from the geographic center of the region, latitude, longitude, and the ratio of amphibians : reptiles (a metric of the community saturation of the two groups). In order of importance, richness of amphibians was best predicted by longitude, distance from center of the region, rainfall, and the amphibian: reptile ratio. For snakes, richness was predicted by the amphibian: reptile ratio and rainfall.

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Species richness and composition of amphibians and reptiles on isolated tabletop mountains of the Guayana Shield

Tepuis are isolated tabletop mountains of the Guayana Shield in northern South America. Here we investigate patterns of species richness and composition of the herpetofauna of Pantepui (the informal biogeographic province representing tepui summits) from the perspective of island biogeography. We describe the relationship between species richness, area, and five measures of isolation (elevation, summit-slope ratio, nearest neighbor distance, distance to nearest larger tepui, and straight-line distance from the Andes), as well as patterns of faunal nestedness. Because the Pantepui biota is characterized by high levels of endemism, we also describe associations between endemism, area and isolation. We present results from across Pantepui and within eastern, northern, western, and southern subdistricts. Elevation and area were the two variables that best explained species richness of both reptiles and amphibians across Pantepui. Nestedness was significant for amphibians but not reptiles in Pantepui, and amphibian nestedness was best explained by distance from the Andes and elevation. There was a decrease in nestedness from east to west, resulting from

an increase in endemism along the same gradient. This increase in endemism was very closely associated with an increase in summit-slope ratios along the same geographic gradient. Thus, high levels of endemism in the western subdistrict are ascribed to the fact that western tepuis are characterized by relatively steep slopes and sheer cliffs that effectively isolate them from the lowlands and other tepuis, providing a fertile ground for evolution of endemic taxa.

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Optimal foraging behavior and diet overlap in two ambush predators in southeastern Arizona: *Sceloporus jarrovi* and *Sceloporus virgatus*

Optimal foraging theory states that given a diverse selection in prey choice, predators will minimize energy capturing prey to maximize energy intake over time. Whether or not to consume a particular prey item is also affected by the abundance of prey with greater nutritional value. Thus, an optimally foraging predator must be capable of determining nutritional value of its various prey, as well as their relative abundances. Both *Sceloporus jarrovi* and *Sceloporus virgatus* are sit-and-wait insectivorous lizards common to southeastern Arizona. In order to ascertain prey choice and the level of optimality exhibited in these two species, I observed the predatory behaviors of two age classes of *S. jarrovi* (adult and neonate) and adult *S. virgatus*, while sampling for insect abundance. In addition, I sampled stomach contents of the same lizard groups to determine total diet composition. Average profitability per lizard diet was highest for *S. jarrovi* adults, followed by *S. virgatus* adults and *S. jarrovi* neonates. Stomach contents showed that the dominant food item for all these lizard groups were the Hymenopteran ants; though their profitability is low, the ants are readily available in high quantities in the environment. Those items that were most profitable (Odonata, Orthoptera, and Lepidopteran adults and larvae) made up 5 percent or less of the diet, likely due to their decreased availability. These data indicate that although the adults of the two species are foraging more profitability than the neonates, all lizards are primarily feeding on those prey items that are readily available, because the more profitable items are rare; this is consistent with optimal foraging theory. There was also high diet overlap between the three lizard groups, indicating that competition for food may not be a factor, due either to an adequate prey base or low lizard population densities.

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Reproductive biology of an invasive species, the Brown Tree Snake (*Boiga irregularis*)

The brown tree snake (*Boiga irregularis*) was accidentally brought to the island of Guam and quickly became established throughout the island. This introduction has resulted in the loss of many native species and has had a large economic impact on the island. Of particular concern is that the snakes will also become established in other locations, especially Hawaii. Although this population has been monitored and managed for over twenty years, the reproductive cycle of brown tree snakes on Guam has yet to be described. Preliminary data suggest that males with mature sperm can be found all year on Guam, but the proportion

of males that are undergoing active spermiation varies seasonally. Previous research has found that few snakes of reproductive size (reproductively competent) are actually reproductively active. Most individuals have very low levels of plasma sex steroids and snakes from Guam also have higher levels of the stress hormone corticosterone than those from the native range or in captivity. Brown tree snakes on Guam also have a significantly lower body composition index (the residual from the linear regression of mass on snout-vent length) than captive brown tree snakes or those from Australia. It is possible that reproductively competent adult snakes are unable to find enough food to maintain body condition, so the majority of them are not reproductively active during any given season. We manipulated the diet of captive snakes on Guam to explore the effects of food intake on sex steroid and corticosterone production, with the hypothesis that the *high food* group would show an increase in sex steroids and a decrease in corticosterone when compared to the *low food* group. A better understanding of the reproductive cycle and constraints of this species will aid in management efforts on Guam.

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Behavioral evidence for magnetoreception in the red-sided garter snake

Long-distance migrations between seasonal habitats and successful return following displacement have been considered evidence that snakes are able to navigate over long distances. However, the means by which they navigate have been little explored. Some studies have found evidence for celestial cues (position of the sun or polarized light) while others point to visual cues (landmark recognition) as mechanisms of navigation. Sea turtles and alligators orient using the earth's magnetic field, but as far as we know this has never been tested in snakes. To examine whether garter snakes respond to magnetic cues, we collected male red-sided garter snakes (*Thamnophis sirtalis parietalis*) from the Interlake region of Manitoba, Canada, in May 2005 and transported them southwest to Corvallis, Oregon to create a long distance displacement. We then video-recorded baseline directional preferences of these snakes in a circular arena. The snakes were later retested with either a small, strong magnet or an equivalent-mass brass weight attached to the head. The mean angle of dispersal of the control (brass weight) group did not differ significantly from that of the baseline (no weight or magnet) group, while the mean angle of the magnet group was significantly different from the baseline mean angle. These results imply that *T.s.parietalis* can detect magnetic fields and therefore may use them in their long-distance migrations back to den sites in the fall; future research will involve similar experiments conducted in the field.

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Diet of the Northern Pacific Rattlesnake (*Crotalus oreganus oreganus*) within the Yakima River Canyon of Washington State

I investigated the diet of a population of the Northern Pacific Rattlesnake (*Crotalus oreganus oreganus*) in Washington state. A total of 122 prey items was identified from 420 snakes collected as either dead-on-road (DOR) or alive-on-road (AOR) from May through October 2003-2005. Snakes were measured, weighed and placed into three size classes; <30 cm, 30-60 cm, and >60 cm. The stomachs and intestinal tracts of DOR snakes (n = 384) were examined for prey items and fecal material. The stomachs of all AOR snakes (n = 36) were palpated to collect any prey items, which were identified to the lowest taxonomic level, weighed and preserved. Small mammals (e.g. deer mice (*Peromyscus maniculatus*) Great Basin pocket mice (*Perognathus parvus*) and voles (*Microtus* spp.)) were the most frequent prey item in the diet (74 %) followed by lizards (20 %) and birds (6%). Predator-prey mass ratios ranged from 0.02-0.94. Larger snakes did not necessarily ingest larger prey items, but do have a more diverse diet. Diet was independent of sex, but not size class. Snakes contained multiple prey items (2-6) from April to June, but rarely later in the season. In addition, we compare our data with other populations of *C. o. oreganus* in the Pacific Northwest.

***WEAVER, ROBERT E; DARDA, DAVID M.**

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Comparative ecology of the Ring-neck snake (*Diadophis punctatus*) and Sharp-tailed snake (*Contia tenuis*) in Washington state

We investigated the ecology of two secretive species of Pacific Northwest snakes, the Ring-neck (*Diadophis punctatus*) and the Sharp-tailed Snake (*Contia tenuis*). A total of 135 snakes were collected from April-October 2002-2005 from three counties (Kittitas, Klickitat, and Yakima). Forty-five specimens of *D. punctatus* were collected within Oregon white oak (*Quercus garryana*) savannah, and along riparian zones in the shrub steppe zone, an area characterized by big sage (*Artemisia tridentata*) and rabbitbrush (*Chrysothalmus* spp.) shrubs. Specimens were active from 1200-1500 h in April and May, and September, at air temperatures of 18-23°C. Extensive surveying was conducted at night, with no specimens observed. Prey items of adults included Western Skinks (*Eumeces skiltonianus*) and small Gartersnakes (*Thamnophis* spp.). Limited data indicates the diet of juveniles and hatchlings are earthworms and insect larvae. Reproductive data showed female *D. punctatus* to have enlarged follicles or ova from May to June, with hatchling specimens collected in August and September. Eighty

specimens of *C. tenuis* were collected from March-October. Unlike *D. punctatus*, specimens were collected during the day (0900-1600 h) and at night (2000-0300 h), and at a wider range of air temperatures (10-32°C). Anecdotal reports indicate that *C. tenuis* is active on the surface after rain fall. However, during this study several specimens were collected on the surface during the hottest, driest times of the year. Like *D. punctatus*, specimens of *C. tenuis* were collected within the shrub-steppe zone, but also within dense coniferous forests, and many areas of human disturbance (agricultural, residential, and commercial areas). Female *C. tenuis* with enlarged follicles or ova were collected from April-July, with hatchlings collected Sept-Oct. Unfortunately no prey items were collected from specimens *C. tenuis*. Our study shows *C. tenuis* to more abundant and widespread. However, *D. punctatus* is less abundant, and restricted in terms of distribution and habitat preference.

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Habitat use and the effects of trawling on fish and invertebrate communities on the northern Gulf of Mexico continental shelf

Habitat disturbance from trawling is a major threat to marine biodiversity that destroys critical biogenic and sedimentary habitat structure for benthic species. The Gulf of Mexico trawl fishery targets shrimp in soft-sediment habitat that is assumed to be of low structural and species diversity; however, trawling is not confined solely to soft-sediments, but rather to a suite of different habitat types. The goals of this study were both to characterize habitat use patterns of fish and invertebrate communities and to assess the effects of trawling on these communities and their associated habitats over sand, shell-rubble, and natural hard bottom reef substrates. Quarterly trawl surveys were conducted over a two year period to quantify fish and invertebrate habitat use patterns in conjunction with concomitant remote operated vehicle (ROV) transects used to quantify habitat characteristics. Results of the habitat characteristics and their influence on the biotic community will be discussed. Fish and invertebrate communities showed distinct differences among habitat types and with respect to trawling exposure. The total number of species and the total number of individuals were highest over non-trawled sand habitat; however, both evenness and diversity were highest on non-trawled shell-rubble habitat. Length-frequency distributions on the most influential fish species characterizing the communities indicated a truncated size distribution over trawled habitats when compared to similar non-trawled habitat type. This study demonstrated habitat-specific differences in the community structure and highlighted the anthropogenic impacts that trawling has on the biological community and the associated habitat.

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The Status of *Etheostoma osburni* (Candy Darter) in West Virginia

Etheostoma osburni is endemic to the upper Kanawha River system of West Virginia and Virginia. It inhabits cool to warm waters of small streams to medium sized rivers in the Ridge and Valley Province of Virginia and West Virginia, and the Appalachian Plateau of West Virginia. Due to extirpations

and/or low numbers at certain sites and a lack of recent data, conservation documents have listed this fish as a species of concern in both states and consequently, at the federal level. In 1991, a survey to determine the abundance of candy darters at historic locations in the Monongahela National Forest suggested that West Virginia's population was declining. In response to this limited survey and the federal designation, the West Virginia Division of Natural Resources initiated a survey in 1993 to evaluate the status of the candy darter throughout its entire range in the state. To date, approximately 40 of 50 historic candy darter sites (i.e., localities established prior to 1980) have been visited, including many sites during 2005. This new information reveals that, although this species is probably declining or has been extirpated from certain waters within its West Virginia range, several excellent sites still exist. Reasons for population declines are presented and new threats are identified, including hybridization with the introduced variegate darter.

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Movement, behavior and habitat of juvenile white sharks in the eastern Pacific

Six juvenile white sharks ranging in age-class from 1 to 3 years were tagged in the Southern California Bight using pop-up satellite archival tags. Young-of-the-year white sharks in the Eastern Pacific occupy a larger nursery area than suggested in previous studies, spanning California Current waters of Southern California and Baja California, Mexico. Young-of-the-year sharks preferred surface mixed layer waters of 16-20C but made frequent movements through the thermocline, and showed a strong diel pattern in behavior. Three-year-old sharks used a larger geographic, vertical and thermal habitat, making movements to greater depths and cooler temperatures, and one individual moving into cooler waters north of Point Conception. This ontogenetic thermal niche expansion suggests that young-of-the-year sharks are thermally limited in their habitat. Juvenile white sharks are captured as bycatch in both US and Mexican waters, suggesting that management of fishing mortality should be of increased concern.

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Venom evolution in *Bothrops* and related Neotropical pitvipers

In the last decade great strides have been made in resolving the phylogenetic relationships of New World pitvipers based on DNA sequence analysis of various mitochondrial and nuclear genes. While the relationships of some problematic taxa remain unclear the general picture of pitviper phylogeny is now robust. Parallel to this effort has been rapid progress in the molecular characterization of important venom components related to their structure, function and evolution. The connection between species phylogeny and the evolution of venom components has not been fully explored. This paper examines the phylogenetic patterning of important differences in venom components of bothropoid pitvipers (*Atropoides*, *Bothrops*, *Lachesis*, etc.) as compared to other New World forms (*Crotalus*, *Sistrurus*, *Agkistrodon*). Primary consideration is given to secretory phospholipases (sPLA₂), their role in neurotoxicity and myotoxicity, and to metalloproteinases that are the primary mediators of hemorrhage and coagulopathy.

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Recent growth and renovations within The Auburn University Museum fish collection

The Auburn University Museum fish collection comprises 44,167 catalogued lots of fishes representing 3288 species in 235 families. Since 1998, collection personnel have catalogued over 16,000 including a large backlog of fishes from the southeastern United States and recent accessions that include materials from expeditions to Bangladesh, Guyana, Indonesia, Peru, and Venezuela. In 2004, the fish collection expanded into new space to accommodate future growth needs.

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Labroid phylogeny and the search for perciform relatives using outgroup jackknifing

The question of relationships among the labroid fishes (cichlids, damselfishes, surfperches and wrasses) has been the subject of intensive research by morphologists for many years. A primary focus of this research has been the pharyngeal region, which yields a number of characters suggesting their close

relationship. Recently, molecular data have questioned this close alliance, suggesting that cichlids, pomacentrids, and embiotocids are closely related but that labrids are rooted to a different part of the perciform tree. Neither morphology nor DNA has yet provided a clear answer to the question of what other perciform fish families might be close relatives to labroid families. Key questions remain: Are labroids one clade or more? What non-labroid families are close relatives to these families? In this context, we assembled a dataset consisting of DNA sequences from mitochondrial and nuclear genes from over 120 perciform taxa including all major labroid clades to test hypotheses of labroid relationships. Six genes and about 4KB were analyzed using outgroup jackknifing, in which alternative sets of outgroups were used to assess support for labroid clades. The molecular evidence strongly supports the sister-pair of embiotocids and pomacentrids, with cichlids a close relative but often with other families inserted. The labrids are more closely allied with more basal percoid lineages, with the Gerreidae a possible sister-group to the Labridae. Phylogenetic hypotheses splitting labroid fishes into two or more clades do not require many extra steps when considering morphological character data, but do require reinterpretation of both structural and functional hypotheses of pharyngeal jaw evolution in fishes.

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Primordial germ cell determination in fish

In sexually reproducing organisms germ cells are indispensable for continuation of the genealogical lineage. In classical model organisms such as nematodes, fruit flies, and frogs, primordial germ cells (PGCs) are determined by maternal molecules sequestered in specific regions of the oocyte and embryo. In salamanders and mammals, PGCs are not predetermined, and they must be induced later in development. Our review of PGC determination in fish indicates that, as in amphibians, both mechanisms are present. In zebrafish (*Danio rerio*), experimental evidence demonstrates that PGCs are specified by maternal determinants. Germ plasm in embryos can be tracked by the expression of vasa RNA and dazl RNA, both of which are localized in the oocyte and early embryo. Localized vasa expression has been found in the blastula stage in a basal teleost, the butterfly fish (*Pantodon buchholzi*), as well as several other teleost fish: the carp (*Cyprinus carpio*), the tetra (*Hyphessobryon ecuadoriensis*), and Fegrades danio (*Danio feegradei*). The pattern resembled that seen in zebrafish at a similar stage. In contrast, our preliminary evidence indicates that vasa RNA and dazl RNA are uniformly distributed in the cytoplasm of oocytes from sturgeon (*Acipenser fulvescens*), a primitive actinopterygian fish. In lungfish (*Protopterus annectans*), a sarcopterygian fish, vasa RNA is also not localized in oocytes. Vasa RNA localization is not seen in early embryos of three teleost fish: the medaka (*Oryzias*

latipes), the trout (*Oncorhynchus mykiss*), and the rainbow fish (*Melanotaenia fluviatilis*). These results suggest that even among teleosts, both mechanisms of germ cell determination occur. The evolution of the mechanism for germ cell determination and its affect on potential developmental constraints to morphological change will be discussed.

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Organization and variation in the Least Brook lamprey control region

The lamprey mitochondrial control region is unique among vertebrates in that it is composed of two distinct regions separated by t-RNAs. Here we describe the structure of the control region in the Least Brook (*Lampetra aepyptera* - LBL) and American Brook lampreys (*L. appendix* - ABL). Several of the conserved regions typically seen in vertebrate sequences are not apparent in the lamprey sequence. All lampreys examined possess multiple copies of a 39-base repeat. Whereas the Sea lamprey (*Petromyzon*) and the European River lamprey (*L. fluviatilis*) have 3 copies, populations of LBL can have 4 or 5 copies. Typically the last copy is imperfect or is only a fragment of a normal repeat. However certain populations of LBL have the first two copies imperfect. When the number of repeats is superimposed on a phylogeny, we observed cases of a change in repeat number within a clade. The repeats are capable of forming secondary structures of variable stability. The second part of the control region is preceded by the Thr and Glu t-RNA genes. It consists of a short (12 bp) conserved region followed by multiple copies of a second repeat sequence of 25-29 bp. A consensus repeat sequence is apparent in some LBL populations but not all. These repeats can also form secondary structures. Poly-T and poly-A sequences were common and prevented accurate sequencing of the entire region. A 13 bp unique region is found at the end of the repeats. The LBL control region appears to be a very dynamic region.

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Biology meets engineering: biomechanics and two-dimensional finite element analysis of carcharhinid teeth

Applying engineering techniques to biological studies can reveal functional insights into evolution undiscovered by traditional methods. The goal of this study was therefore to explore the evolution of selachian teeth in a biomechanical context. To determine the loads experienced by shark teeth during

puncture and unidirectional draw, teeth from nine carcharhinid species were tested with a MTS MiniBionix II universal testing system. Puncture forces were determined by driving teeth into three teleosts of varying scale thickness at 400 mm/s. For unidirectional draw, teeth were embedded in the prey item and drawn in parallel at 400 mm/s. Force and pressure at initial penetration and maximum force and pressure were determined from both sets of experiments. Stress and strain distributions in the teeth were then computed via two-dimensional finite element (FE) analysis, using the measured maximum forces and mechanical properties of mammalian teeth. FE models of various carcharhinid tooth morphologies were created from the coordinates of tooth outlines from digital images. Tooth models were fixed at the base and point loaded at the tip for puncture and on the lateral cutting edges for unidirectional draw. Initial results indicate minimal strain in the teeth under either loading. During puncture, stress is concentrated primarily at the tooth tip for all morphologies. However, teeth with narrow triangular cusps, like those of *Carcharhinus limbatus*, have smaller regions of stress concentration overall than those with broad, curved cusps like *C. leucas*, in which a region of high stress extends along the lateral cutting edge. A stress concentration often occurs at a corner of the tooth base during unidirectional draw. High stress occurs along the cusp-base interface for narrow triangular cusps, and where the lateral cutting edge meets the base for broad, curved cusps. Overlapping bases and flexible attachment of teeth may alleviate these stresses in live sharks.

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Faunal declines across 35 years at La Selva, Costa Rica: More trouble in paradise?

Amphibian declines are a critical issue in conservation ecology, and enigmatic declines in pristine habitats have evoked particular alarm. However, lack of long-term data makes it difficult to assess the status of most populations. We reviewed published and unpublished reports of density of forest-floor amphibians and reptiles at La Selva Biological Station, a large, relatively pristine, lowland wet forest in northeastern Costa Rica. Total density of all amphibians declined an order of magnitude between 1970 and 2005 in primary forest, but total density increased in adjacent abandoned cacao plantations undergoing succession. Unexpectedly, reptile populations show trends identical to those for amphibians. All species of amphibians and reptiles declined significantly in primary forest, while one third of species present in cacao increased in density. Community-wide declines of such intensity and duration likely indicate an external driver of density rather than natural fluctuations. A parsimonious explanation for the patterns reported here cannot be provided by major processes currently implicated in amphibian declines. Habitat modification and fragmentation are not likely explanations because La Selva is a large protected reserve. Pesticide drift cannot explain increase in total density in successional plantations. Emerging diseases can neither explain declines among reptiles nor population increases in cacao. We suggest that trends for La Selva are best explained by changes in dynamics of forest-floor leaf litter, a major determinant of abundance for this assemblage. Recent changes in climate at La Selva may accelerate decomposition of leaf litter in both habitat types, yet increasing litterfall with forest succession may explain increases in density in cacao. This study indicates that our understanding of faunal declines is still incomplete, suggests that habitat protection alone may be insufficient for the preservation of biodiversity, and demonstrates the value of long-term datasets for assessing status of populations.

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Isolation and partial sequence analysis of *lhx9* in the red-eared slider turtle, *Trachemys scripta*

Many reptiles, including the red-eared slider turtle (*Trachemys scripta*), possess a temperature-dependent sex determination (TSD) mechanism where the temperature at which the developing embryos are incubated dictates the eventual gonadal sex of the animal. A cascade of regulatory genes controlling sex determination has been identified in some mammals and reptiles. Some orthologous genes of this cascade show a high degree of homology among mammals, reptiles, and birds. One such gene, *Lhx9*, controls the proliferation of gonadal cells in mice and its absence drastically reduces the expression of other genes in the male developmental pathway. In addition, *in vitro* studies using mouse models have shown that *Lhx9* binds to and activates SF-1 (steroidogenic factor 1), a central gene regulating the expression of steroidogenic enzymes in the bipotential gonad. We studied *Lhx9* and its role in TSD in the red-eared slider turtle. Using degenerate oligonucleotide primers, we PCR-amplified then sequenced a 342 bp fragment of exon 3 from red-eared slider turtle genomic DNA. DNA sequence alignment of this fragment revealed 92.7% and 84.5% identity with its ortholog from chicken and mouse, respectively. This high degree of sequence homology among the three species indicates that *Lhx9* of the red-eared slider turtle may have a similar function in the sex determination pathway as in mouse with its influence on SF-1. We are currently characterizing the expression patterns of *Lhx9* during embryogenesis in the red-eared slider turtle to reveal its role in TSD.

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Combining satellite, bathymetry, and sediment data to refine ecological niche models and predictions of species occurrences

Our research group has previously demonstrated that statistically robust ecological niche predictions can be used to predict the occurrences of marine fishes using station-based and MODIS satellite data in concert with bathymetry. In this study we combine MODIS, sediment, and bathymetry coverages to further refine the ability of genetic algorithms to predict species occurrences and contrast the results with previous studies.

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Retention of coded-wire tags in the green anole, *anolis carolinensis*

Our goal was to assess the feasibility of using coded-wire tags (CWT) to batch mark anolis lizards. The green anole *Anolis carolinensis* was selected for this study because of its local abundance. The objectives were to compare the growth and survival rates of, coded wire tagged, toe clipped, and control lizards, as well as to determine the long-term retention rate of CWT in anolis lizards. Each lizard was sexed, weighed, and the snout-vent and snout-tail lengths were measured. Lizards (N=63) were randomly assigned to one of three replicates of each treatment (seven lizards per replicate). Lizards were maintained outdoors in sheltered 38 liter glass aquaria and were fed and watered once a day. Data were analyzed using analysis of co-variance (ANCOVA) to account for size variation among individuals and to compare pre- and post- growth. From 25 July to 25 August of 2005, retention of coded-wire tags was 100%. Six percent mortality occurred in the toe clipped and control treatments. There were no significant differences in growth rates across all treatments. Control and toe clipped lizards were released after the survival and growth comparison among treatments. Coded wire tagged lizards were transferred to 91x61x91cm cages for assessment of long-term CWT retention. Lizard were moved indoors and were maintained at $24.7 \pm 2.0^{\circ}$ C once outdoor temperatures dropped below 20° C. No mortalities occurred and long-term tag retention over seven months was 95%. CWT can be used successfully to batch mark anolis lizards. Based on the results of this study, CWT have been used to mark brown anoles *A. sagrei*, a species native to the Caribbean that can now be found in Southeastern Louisiana, for estimations of population size using mark recapture techniques. Additionally, this method of tagging will be used to document over-wintering of the brown anole in Southeast Louisiana.

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Coevolution of deadly toxins and predator resistance: Behavioral rejection of toxic newt prey by garter snakes

Deadly toxins and resistance to them are an evolutionary enigma. Selection for increased resistance does not occur if predators do not survive encounters with toxic prey. Similarly, deadly toxins are of no advantage to individual prey if they

die delivering the toxins. For individual selection to drive the coevolutionary arms race between resistant predators and lethal prey, the survivorship of individual predators must covary with their resistance. The extreme toxicity of the rough skinned newt (*Taricha granulosa*) appears to have coevolved with resistance in its predator, the common garter snake (*Thamnophis sirtalis*), yet the mechanism by which individual selection can operate has been unclear in this and other lethal prey-predator systems. We show that individual snakes assess their own resistance relative to newt toxicity and reject prey too toxic to consume. Rejected newts all survived attacks and attempted ingestion by snakes that sometimes lasted over 50 min. Behavioral moderation of toxin exposure by snakes provides the association between individual resistance and fitness necessary for coevolution of lethal toxins and resistance to occur.

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**The Relationship Between El Niño/Southern Oscillation Events and
Growth of Juvenile White Seabass (*Atractoscion nobilis*)**

Since 1995, the Nearshore Marine Fish Research Program (NMFRP) at CSUN has been under contract with the California Department of Fish and Game and the Ocean Resources Enhancement and Hatchery Program to sample and determine the spatial and size distributions, seasonality, and abundance of white seabass (*Atractoscion nobilis*) in the shallow, nearshore waters of Southern California. One hundred sagittal otoliths were aged from each sampling year between 1997 and 2004. The hatch year of each fish was back calculated using the age at catch and the catch year. Growth rates are determined by using the means of standard length at age for each hatch year. Linear regression equations for each set of hatch year data provide a general growth rate for the first few years of life. The large time span of this study includes several El Niño/Southern Oscillation (ENSO) events of varying strengths, all of which caused noticeable changes in the sea surface temperature in the Southern California Bight. This study relates the growth rate of juvenile white seabass and the changes in the local ocean temperatures due to ENSO conditions.

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**A progress report on a Barstovian (Middle Miocene) herpetofauna from
Fort Polk military installation, Louisiana, USA**

The Miocene herpetofauna from west-central Louisiana is important in the field of paleoherpetology, as there is nothing else known of Miocene Gulf Coast herpetofaunas between east Texas and the Florida panhandle. In twelve years of work by LSU paleontologists, dissolving rock, deflocculating clay, and picking microvertebrates under a microscope, 9175.9 kilograms of sediment have been processed from six Miocene-aged (13.5 million years old) fossil-bearing sites on the Fort Polk, Louisiana military base. Stonehenge, the most prolific site, has yielded 315 identifiable herpetological postcranial elements in 3050.91 kilograms of screen-washed sediments or 0.103 elements per kilogram. The next most prolific site is TVOR, which has 0.024 herpetological elements per kilogram of sediment. Thus far, colubrid and viperid snakes have been recovered, including *Thamnophis* sp., *Elaphe* sp., and a species of *Texasophis*. Ranid and bufonid anurans have been identified using ilial characters, and 68 salamander vertebrae have been separated from bulk collections for study. One of the salamander

vertebrae compares favorably to the Barstovian *Batrachosauroides dissimulans* from Florida and Georgia. A lizard dentary, belonging to *Eumeces* sp., exhibits bulbous tooth crowns that are unlike any modern species of *Eumeces* living in Louisiana today and might represent a new species. Finally, the presence of numerous crocodilian teeth, trionychid carapace fragments, natricine snake vertebrae, and ranid frog ilia at the Fort Polk sites suggest permanent freshwater sources near the areas in which the animals lived.

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Influence of the Casiquiare connection on biogeography of Neotropical fishes: Inferences from *Cichla* mitochondria

Previous molecular phylogeographic studies of South American fishes emphasized closer relationships among taxa and lineages from the Amazonas basin and coastal Guyanan drainages to the exclusion of the portions of the Orinoco basin. Despite this pattern, a significant direct connection between the Amazonas and Orinoco basins currently occurs through the Casiquiare river, a tributary of the Amazonas that captures a portion of the headwaters of the Orinoco and provides a potential corridor for movement of fishes between the basins. Rather, this incongruence between biological pattern and contemporary hydrography probably implicates a major role for the complex evolution of South American hydrography through geological time in taxonomic diversification and prehistoric demographics of South American fishes. Four of eight putative species of *Cichla* show distributions in both the Orinoco and Amazonas drainages, but these overlapping distributions were arrived upon from different biogeographic backgrounds and in different temporal contexts. Mitochondrial control region data from individuals throughout the range of each species were collected to examine the geographic structure of genetic diversity. Analyses revealed that each species differs in the structure of genetic diversity across this barrier. For all species, analyses show definite geospatial correlation, i.e., haplotypes from particular localities and geographical areas are often members of the same genetic clades. However, each species showed non-monophyly among haplotype groups from either basin, conflicting with null hypotheses that the Casiquiare prohibits dispersal between basins. *Cichla monoculus* exhibited a pattern of recent range expansion from the Amazonas to the Orinoco, while *C. temensis* showed an older pattern of stochastic lineage sorting (genetic drift) among localities in the Orinoco and Amazonas. *Cichla*

orinocensis showed a pattern of introgression with *C. monocolus* suggesting ancient colonization of the Amazonas from the Orinoco, and *C. intermedia* showed recent co-ancestry in the Casiquiare and Orinoco but population fragmentation within the Orinoco.

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Evaluation of trap response in two aquatic snake species using mark recapture and an experimental release study

We use data from one year of intensive systematic mark-recapture sampling (2325 captures of 888 individuals) of two aquatic snake species (*Seminatrix pygaea* and *Nerodia fasciata*) using aquatic funnel traps to evaluate factors that influence snake capture rates. Specifically, we examine inter and intraspecific differences in capture probability, including heterogeneity in individual capture probability, behavioral ("trap-happy" or "trap-shy") responses, and time effects. Additionally, we use an experimental release study to examine the potential role of escape from traps in generating the capture patterns we observed. Mark-recapture analyses using program CAPTURE yielded strong support for heterogeneity in capture probability for *N. fasciata* and, to a lesser extent, for *S. pygaea*. There was generally weak support for behavioral or time-dependent response for either species. Despite the intensity of our sampling regime, average individual capture probability was low, but was similar between species (0.04 - 0.15 per night). Within *S. pygaea*, males displayed fairly constant capture probability across the year. Females displayed lower capture probability in the summer, most likely corresponding to reduced activity during pregnancy. Young *N. fasciata*, born mid-summer, had substantially lower individual capture probability than adults. Experimental releases of 196 snakes demonstrated that *S. pygaea* escape from traps far more frequently than *N. fasciata*, even accounting for body size. In both species, smaller snakes escape more frequently. We found a strong effect of capture history on propensity to escape in *N. fasciata*, but not in *S. pygaea*. This correlation between number of previous captures and propensity to escape may partially explain the heterogeneity in capture probability we observed for *N. fasciata*. Our results demonstrate that indices of relative abundance may be biased in multiple ways and must be used with caution when making inferences about snake populations.

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Reconsidering Chirixalus (Anura: Rhacophoridae): A phylogenetic analysis

We re-examine the status of the genus *Chirixalus* within the larger context of the family Rhacophoridae. Although morphological characters support the monophyly of the genus, molecular work (Wilkinson et al 2002) recovered a polyphyletic *Chirixalus*. Increased taxon sampling within the genus in combination with additional molecular markers provided a more robust estimate of phylogenetic relationships. Data were analyzed using maximum parsimony, maximum likelihood and Bayesian Inference.

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Comparison of dietary and isotope-based food web structure of four Central American coastal streams

Food web structure of two coastal streams in Corcovado National Park (Pacific Costa Rica) and two coastal streams in Tortuguero National Park (Caribbean Costa Rica) were examined via analysis of fish stomach contents. Stream drainages in both regions drain tropical rainforest landscapes. This analysis, performed in 1983 and 1985, revealed details of predator-prey interactions and structure involving upper food web elements. The same sites were surveyed again in 2004 to assess food web structure via analysis of stable isotopes in tissues of fishes, macroinvertebrates and plants. Stable isotope analysis (SIA) provides integrated estimates of assimilated production sources but usually is a poor predictor of pairwise trophic interactions. Analysis of nitrogen isotope ratios provides an independent method for assessment of vertical consumer trophic positions. Coefficients of determination for trophic positions based on dietary versus those based on SIA ranged from 0.25 (Corcovado stream) to 0.54 (Tortuguero stream). Phytoplankton is extremely sparse in these systems, and most fishes and macroinvertebrates had carbon isotope ratios that were considerably heavier than local benthic algae. Variable fractions of carbon from terrestrial vegetation, and to a lesser extent from aquatic plants in Tortuguero streams, probably were assimilated by consumers in all four streams. Approximately half the consumers in all four streams had carbon ratios that were heavier than any of the local production sources examined. This pattern seems to be associated with species that migrate from coastal waters or feed on

migratory species, and highlights the importance of trophic links between ecosystems in coastal zones for understanding food web dynamics.

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Rapid recovery of an aquatic snake community following prolonged drought

Coping with climatic variation and associated fluctuations in resource levels is one of the greatest challenges to organisms in many ecosystems. Extreme drought, in particular, is among the most powerful selective forces and has been implicated in the evolution of numerous species, character traits, and life-history attributes. For aquatic organisms inhabiting isolated wetlands specifically, droughts pose one of the most obvious challenges to population stability and persistence. We have monitored the aquatic snake community at a large (10-ha), isolated freshwater wetland (Ellenton Bay) since it began to refill after a 2.5-year drought that occurred from August 2000 to February 2003. *Seminatrix pygaea* survive droughts by aestivating within the dried wetland and exhibit similar relative abundance in pre- and post-drought years, whereas sympatric semi-aquatic natricines that do not aestivate (*Nerodia fasciata* and *N. floridana*) experience precipitous declines or local extinction during the drought. Here, we document patterns of population recovery for *S. pygaea*, *N. fasciata*, and the wetland snake community as a whole in the 3.5 years since the wetland was last dry. In particular, we demonstrate that *N. fasciata* rapidly repopulated Ellenton Bay, returning to pre-drought abundance levels within three years. *Seminatrix pygaea* increased in abundance and achieved record body sizes and levels of reproduction during the post-drought period. Overwhelmingly, the rapid recovery of the snake community appears to be driven by changes in amphibian prey abundances, which have increased substantially since the refilling of the wetland in 2003. Our results are analogous to “supranormal” breeding events of wetland birds following recovery from extreme drought and highlight important interspecific differences in population recovery.

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The diversity and evolution of the gobiid genus *Trimma*

The Indo-West Pacific marine gobiid genus *Trimma* contains about 46 described species, and perhaps as many again that are currently undescribed. The number of the latter increases every time collections are made below 50 m, so it is currently impossible to estimate the total number of species that make up the genus. However, a number of possible phylogenetic lineages, evidenced by presently untested putative apomorphies, are apparent. I will discuss some of this diversity and some of the lineages, and speculate on the ecological importance of a few of the more abundant species in terms of reef energetics.

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Multi-year comparison of male reproductive biology of the brown
treesnake (*Boiga irregularis*)

The brown treesnake (*Boiga irregularis*) is an introduced species on Guam which has caused the extinction or extirpation of several species of lizards and birds. Moore et al. (2005, Biological Conservation 121:91-98) suggested that reproduction in this species is reduced because of elevated stress hormones caused by limited food availability. The purpose of this study is to compare the reproductive anatomy of male brown treesnakes on Guam over several years (1985, 1995 and 1999) to determine if the size at maturity and development of the testis and sexual segment of the kidney varied between years. These measurements were compared to a sample of brown treesnakes collected from the native range of this species. Reproductive adults on Guam were present in all years examined. The snout-vent length (SVL) at which snakes were reproductive was similar between years. Mean seminiferous tubule and sexual segment of the kidney (SSK) diameters were not significantly different between years. However, the number of SSK tubules hypertrophied per snake varied greatly. In general, snakes from the native range matured at a smaller SVL and had many more hypertrophied SSK tubules per kidney than did the populations on Guam.

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Shovelnose Sturgeons (Scaphirhynchinae): Known knowns, known unknowns, and the unknown unknowables based on genetic analysis

The shovelnose sturgeons of the subfamily Scaphirhynchinae are an important and imperiled component of the large river fauna in North America.

Scaphirhynchus is composed of three species: *S. albus*, *S. platyrhynchus*, and *S. suttkusi*. Both the pallid sturgeon (*S. albus*) and the Alabama sturgeon (*S. suttkusi*) are listed as endangered under the US Endangered Species Act. Whether you agree or disagree with the political perspective that led to the paraphrased title of this talk, there is an ineloquent wisdom in it that is directly applicable to North American shovelnose sturgeons and may be comprehensible to decision makers in the U.S. Fish and Wildlife Service. The former is justified by the extensive genetic data we have assembled on these species and a wisdom borne out of our understanding of the limitations of these data. The latter is supported by the fact that policy makers at the USFWS seem very capable of finding a comfortable interpretation in any set of data no matter how clear or how garbled the message. I will present DNA sequence data and microsatellite data on over 200 North American shovelnose sturgeons representing the above three species and attempt to explain what is known, what is unknown and what is unknowable (but generally assumed to be known) based on a rather large set of genetic data.

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Body size relationships among several species of salamanders in the genus *Desmognathus* (Caudata: Plethodontidae)

Allometric or scaling relationships have been revealed across 27 orders of magnitude in body size, from the smallest genetic constituents to the largest mammals and plants. These relationships have been documented among species, populations, and sexes. Isometry, the converse of allometry, is a relationship in which body mass (or another body size measure, such as length) increases proportionally as body size increases. In the dusky salamander genus *Desmognathus*, it has been hypothesized that these salamanders increase proportionally in body size from the smallest to the largest salamanders. The purpose of this study was to further investigate the isometric relationships among the entire span of body sizes in desmognathine salamanders. Body size relationships were constructed for eight desmognathine species. Ten body measurements were taken for approximately 1300 sexually mature specimens

with equal numbers of males and females. Sex was determined by visual inspection of dissected individuals or by the presence of sexually dimorphic characteristics (e.g., mental gland present such as in mature *Desmognathus wrighti*). Preliminary results suggest that both males ($b=0.96$; $r^2=0.944$) and females ($b=1.00$; $r^2=0.953$) exhibit an isometric relationship of log total length (TL) when regressed on log snout-vent length (SVL). Further investigation into the body size relationships within this genus will be conducted to determine if other measurements exhibit similar trends.

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Transient anatomical features of *Scyliorhinus torazame* embryos

Scyliorhinus torazame is an oviparous elasmobranch and its embryos require 214 ± 26 days to complete development at $14-16^\circ\text{C}$. During this time the embryo and egg case continually adapt to each other. There are four respiratory slits in the egg case, two dorsal and two ventral. The respiratory slits are sealed with solid jelly until 103 ± 6 days at $14-16^\circ\text{C}$ after oviposition. In common with other oviparous elasmobranchs, the tail is used to move water through the egg case via the respiratory slits. The tail has transient anatomical features specialized for development within the egg case. Primary scales found in two rows at the dorsal and ventral margin of both sides of the caudal fin erupt and increase surface area for water movement. The tip of the caudal fin is an extension of the notochord and forms a scoop for water transfer through the egg case by active pumping of the tail. Embryos have been observed to project this tail extension through the hatching terminus of the egg case in the months preceding hatching. The cup-like extension and caudal scales can be observed in embryos after eclosion but are gradually resorbed during the following months. Another specialized embryonic structure to develop during incubation is primary scales found in 2 dorsolateral rows along the trunk. These scales erupt before hatching and may be used to aid in escape from the egg case during eclosion. Ordinary placoid scales do not erupt until after hatching.

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Reproductive biology of Longheaded Eagle Ray, *Aetobatus flagellum*, in Ariake Bay, Kyushu, Japan

The Longheaded Eagle Ray, *Aetobatus flagellum*, has recently increased significantly in number abruptly in Ariake Bay. The eagle ray is a seasonal visitor to Ariake Bay, increasing in number from April, and peaking during the summer. It is assumed that the eagle ray feeds on bivalves and so, to prevent predation on bivalves by eagle rays, a predator control program aimed at reducing the ray population has been in place since 2001. When the program was started, there was no biological information about eagle ray, therefore we clarified to examine their occurrence, age, growth and food in Ariake Bay to obtain data on the ecology of the eagle ray and provide basic information on their potential impact on bivalve stocks. In this study we studied reproductive biology of eagle ray. The size at sexual maturity is 800 mm DW for males and 900 mm DW for females. The histological examination of testis and the seasonal variation of GSI showed the mating occurred during August and October. The fertilized eggs were found from August until next May, and in June the smallest embryos were found in their uterus. The fertilization and parturition were occurred in August because the largest embryos were found in August (average size: 350mm DW), therefore the gestation period was approximately 12 month but the growth of embryos was rapid for 3 month. The fecundity was relatively low that ranged from 1 to 6 embryos. Low fecundity and slower maturity suggested that the predator control program is possible to reduce ray population size. The estuaries are used for their reproduction and nursery ground. The existence of large estuaries is one of the reasons with the recent rising water temperature why they increased in Ariake Bay.

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Comparative brain morphology in elasmobranchs: From structure to function

There is widespread variation in both brain size and complexity across the elasmobranch phylogeny. The relative brain weight of a species is dependent upon the relative enlargement or regression of individual brain structures, some of which can be identified with different sensory modalities and behaviors. The hypothesis that there is an environmental correlation with structural hypertrophy (AES abstract, 2005) was further tested by adding 18 species to the data set. The total database of 46 species from 25 families strengthens the

environmental correlations amongst several families of Chondrichthyans. The data show large variations in relative brain weight and complexity between species that do not follow a simple phylogenetic pattern, as the relative development of the five major brain areas are similar in species that occupy similar habitats. Agile, pelagic species, such as *Prionace glauca* and *Sphyrna zygaena*, have enlarged telencephalons and highly foliated cerebella. Reef-associated benthopelagics have enlarged telencephalons, similar to the pelagic species, but show average cerebellar foliation while bathyal and demersal benthopelagic sharks, such as *Squalus acanthias* and *Dalatias licha*, have enlarged mesencephalon and medulla. Benthic species, such as *Orectolobus ornatus* and *Cephaloscyllium isabella*, have small, smooth cerebella and small telencephalons, though the demersal benthics have enlarged mesencephalons while the reef-associated benthic species have recessed this structure. In batoids, the species that had the highest levels of cerebellar foliation had the most complex batoid wing skeletal structure, adding weight to the hypothesis that there is a cerebellar correlation with fin dexterity. More detailed data will be presented on the cerebellum and the cerebellar like structures and the structure-function relationship of these brain areas. Functional implications of a comparative analysis of these brain structures will be discussed.

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Lessons from five years of promoting international collaborations in amphibian decline research

In 2002, 21 scientists formed the Research and Analysis Network on Neotropical Amphibians (RANA) to accelerate research on population declines and extinctions by providing more fluid communication among researchers, promoting multi-site syntheses, and developing and disseminating data on the population status of Neotropical species. RANA promotes communication among members via annual meetings and symposia, a listserve, and a website. To create a transparent structure, members adopted a charter and elected a five-member board. RANA has succeeded in many of its goals by forming alliances with like-minded groups for specific projects and building trust among collaborators. Coordination with the IUCN and Conservation International led to the completion of the Global Amphibian Assessment, a major resource now available to scientists. Collaboration with an amphibian disease research group based at Arizona State University led to a successful graduate course on techniques for decline research. Research inspired in part by RANA has led to several groundbreaking publications which have narrowed substantially the list of possible causes of declines in Neotropical amphibians. Lessons learned include the importance of choosing collaborators carefully, forming alliances, speaking in a common language, understanding priorities of collaborators, and building trust via face to face meetings. RANA has successfully grown to over 100 members from 60 academic institutions in 21 countries. Nevertheless, maintaining the network requires constant work to maintain cohesion and create new opportunities for fruitful collaboration.

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Rapid colonization of neonate lemon sharks by monogeneans

Sharks are commonly infected by monogeneans (Monogenea); however, few data exist regarding how soon after birth neonates become infected. Fifty juvenile lemon sharks, *Negaprion brevirostris*, captured about Bimini, Bahamas were examined for the presence or absence of monogeneans. Thirty-two percent of the sharks were infected by *Dermophthirius nigrelli*. Twenty-five of these sharks were neonates estimated to be less than 8-10 weeks old and some of these were as young as 3-4 weeks old. Twenty four percent of the neonates were infected by *D. nigrelli*, with the youngest sharks estimated to be 3-4 weeks old. These results indicate that lemon sharks can be infected by *D. nigrelli* soon after birth. This may have important husbandry implications when neonate sharks are selectively

acquired for aquarium operations with the assumption that they will not yet be infected by monogeneans. This study was partially supported by an Undergraduate Research, Scholarship and Creative Activity Scholar award to J. Young from Middle Tennessee State University.

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The fish communities of socotra archipelago: implications for conservation management

Between 1998 and 2002 coastal fish communities of Socotra Archipelago were studied with the objective of assessing patterns of diversity and abundance, community composition, trophic structure and ichthyogeographic affinities. Results were compared with those from other oceanic islands and adjacent coastal areas, and used for an evaluation of existing concepts of marine conservation management and monitoring. The Socotra Archipelago hosts diverse, varied and ichthyogeographically unique inshore fish communities. The structure of the dominant community types, as inferred from multivariate and trophic analysis, is comparable with typical “reef fish” assemblages of the Western Indian Ocean, despite the fact that the Archipelago has hardly any biogenic coral reefs. The numbers of chaetodontid, acanthurid and pseudochromid species exceed those known from the entire Red Sea. Fish diversity and abundance is positively correlated with coral species diversity and the presence of typical mixed benthic communities, which are variably composed of hard and soft corals, macroalgae and sponges. A harsh monsoon regime results in coastal ecosystems varying in space and time, giving rise to a great variety of ecological niches and thus supporting fishes from many different ‘walks of life’. Methods of monitoring and managing tropical marine communities typically focus on rather uniform reef habitats with high cover of scleractinian corals and the presence of so-called “reef-associated” fish species, based on the postulate that these are dominating factors in determining coastal diversity in the tropics. Results from Socotra suggest that habitat availability and connectivity, biotope variability, and linkages among biogeographic units are equally important factors for the establishment of diverse coastal fish communities. Consequently, monitoring and conservation management standards currently applied in the Indian Ocean region need to be adjusted, i.e. giving more consideration to non-reefal benthic communities and to dynamic and varied ecosystems, reflecting more accurately patterns of population dynamics, connectivity and biogeography.

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Temperature sensitivity of the round stingray, *Urobatis halleri*

The round stingray, *Urobatis halleri*, is a common nearshore elasmobranch found in bays and estuaries ranging from southern California to Panama. Round stingrays have been observed to aggregate in great numbers in shallow areas where sea floor water temperatures range from 11° to 21° C within a single tidal cycle. Because rays do not leave these areas during these periods of tidally-induced thermal change, they must be physiologically tolerant to these temperatures. The temperature sensitivity (Q_{10}) of round stingrays was measured using static respirometry. Oxygen consumption rates were measured of rays exposed to two water temperatures of 16° and 21° C over 6 hr periods and their mass specific metabolic rates were determined at each temperature. Rays were found to have a Q_{10} of 2.4, indicating that they are comparatively tolerant to changes in water temperature within their thermal preferenda. This high thermal tolerance enables rays to occupy shallow areas where water temperature fluctuates considerably over the course of a day without significant metabolic consequences.

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Habitat attributes influence ontogenetic diet shifts of gizzard shad (*Dorosoma cepedianum*) in a large floodplain river

Gizzard shad (*Dorosoma cepedianum*) are recognized as an important trophic link in many aquatic food webs because of their ability to link detritus carbon sources with higher trophic levels (e.g. piscivorous fishes). Most research on the feeding ecology of gizzard shad concerns populations stocked in reservoirs whereas populations in more dynamic habitats (river-floodplain systems) have been neglected. Here we examine ontogenetic diet shifts in gizzard shad inhabiting oxbow and channel habitats of the Brazos River, Texas. Using stable isotopes of nitrogen and stomach contents we found that oxbow populations show an increase in the consumption and assimilation of primary consumers (zooplankton) during ontogeny resulting in elevated trophic positions despite high diet overlap values calculated using volumetric proportions of stomach contents. Differences in ^{15}N values indicate that shad greater than 200 mm standard length have a trophic position approximately one level higher than shad less than 200 mm. Populations in the river channel maintain similar trophic positions during ontogeny indicative of detritivory. These results challenge previous models of ontogenetic diet shifts in gizzard shad and similar to other dietary studies using multiple methodologies, suggest that material assimilated may not be proportional to the volume of material consumed.

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**Application of IUCN Red List Criteria in the Status Review for the
Okaloosa Darter**

The Red List Categories and Criteria (IUCN 2001) provide a widely-accepted system for classifying species at high risk of global extinction based on quantitative population and range data. The Okaloosa darter was listed as a species endangered throughout its range in 1973 with a revision to the recovery plan approved in 1998. The USFWS has annually updated the status in the USFWS Threatened and Endangered Species System (TESS) database. However, USFWS has not revised the listing, designated critical habitat, or prepared formal 5-year status reviews since the 1973 listing. As part of the first formal status review for the Okaloosa darter, we applied available population monitoring and range data to Red List criteria and assess the relative risk of extinction for the species apart from any consideration of ongoing conservation measures or threats to its continued existence. Based on our evaluation, the Okaloosa darter did not fully meet any of the five criteria for the threatened status categories under the IUCN Red List system. We found that the classification of the darter as Endangered EN B1+2c by Gimenez Dixon (1996) is not presently warranted. The population satisfied only one and not two of the three qualifiers necessary in addition to a small area of occupancy under criterion B. Criteria for small population size, restricted population size, and probability of extinction were not met. Interpreted most conservatively, the Red List classification for the Okaloosa darter would be Vulnerable VU: B2ab(ii), however we feel that the classification Near Threatened (NT) is a more appropriate designation given the nature of the most plausible threats under criterion B2a.

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Conservation implications of taxonomically revising Panamanian Golden

Frogs

Ongoing studies of mitochondrial DNA (mtDNA) indicate that what was thought to be a single species of golden frog (*Atelopus zeteki*) in Panama is actually two genetically distinct lineages largely indistinguishable in appearance. In the western half of the golden frog's range, animals exhibiting the golden ground coloration might be a color variant of the more wide-ranging *Atelopus varius*, a species typically possessing black ground coloration with pattern accents of yellow and sometimes red. Nuclear genetic studies are underway to supplement the mtDNA phylogeny in clarifying the pattern of historical and recent genetic exchangeability among extant populations. In conjunction with the molecular data, our ongoing morphological, ecological, and demographic analyses suggest that the Panamanian golden frogs and their kin (the *A. varius-zeteki* clade) can be divided into five distinct, geographically isolated forms. These discoveries engender profound implications for the conservation of this already imperiled group of frogs.

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Genetic variation of the frog *Eleutherodactylus ranoides*, Santa Rosa
National Park: Preliminary results

Many amphibian populations have been severely threatened by habitat destruction. In addition, several amphibian populations are threatened by other mysterious causes even in unaltered habitats. Species that inhabit riparian habitats seem to be most affected. The *Eleutherodactylus rugulosus* species group is one of the examples. Several populations of these species have apparently disappeared throughout their distribution. Habitat fragmentation can produce a decrease in the genetic variation in populations affected, increasing the risk of suffering genetic drift. We wish to determine if this effect has occurred to native populations in Costa Rica. We worked at Santa Rosa National Park, Guanacaste province, Costa Rica, during the dry season of 2006. We visited several streams on Naranjo Beach and Santa Elena Peninsula. Frogs were located by visual encounter surveys. We measured each frog with a calliper and determined sex and age. Weight was measured with scale. Geographical location was determined by GPS for each individual. In each stream we collected at least 20 DNA samples by buccal swab and 10 by toe-clipping. DNA concentration obtained by each method was compared. To obtain allelic composition we used 3 loci of microsatellite designed for the species *Eleutherodactylus augusti*. In addition, in each stream we measured the air and water temperatures and pH. Based on our findings we will propose a management scheme that would ensure the medium- and long-term conservation of this species.
