

result of a species tolerance of development, assuming that sensitivity to human development can be inferred from their absence in landscapes that are heavily disturbed, and alternatively, tolerance from occupation. The Hamilton Naturalists' Club has previously collected information on the 31 species of frog, toad, salamander, turtle and snake inhabiting the Hamilton area (in the form of over 14,000 occurrence records, \pm 100 metres). The data includes relative abundance/ distribution, road mortality and specific location information. Analysis of chosen life history traits only explains the pattern of abundance in snakes, with their numbers being closely correlated with fecundity. The spatial situation of species was tested with respect to nine measures of development using a Geographic Information System and the conclusion was reached that sensitivity is highly correlated with abundance. Least common species have little or no development within their summer activity centres, while abundant species are more accepting of disturbance. Built-up areas, such as cities, had the highest impact on the species tested while all species were negatively correlated with non-habitat (such as agriculture), and positively correlated with forest cover. Road mortality, which was not associated with abundance within groups, is correlated with the amount of roads that lie within buffers.

Comparison of various models of the species-area relationship for prediction ability in highly structured ecosystems (P)

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The Species-Area Relationship is one of the foundation theories of ecological work. However, what was originally seen as a simple power relationship is increasingly looking more complicated. Over the past five years, research has shown that there may be more going on than what has been previously anticipated. This has led to proposals of alternate mathematical models for the generation of the Species-Area Relationship. Research has predominantly gone in two directions, the use of models based on the Power Law with added parameters, and the proposal of sigmoidal curves to describe the relationship. This paper is a comparison of the original Power Function to the newly proposed models, a modified Power Function described by Plotkin et al. (2000) and the Extreme Value Function from Williams (1995). These three models were fit to Species-Area data collected in shoreline rockpools on the northern coast of Jamaica, and then statistically analysed for the strength of their ability to predict the relationships seen. The results of this work show the modified Power Function to be the most representative of this data ($r^2 = 0.867$, $P < 0.001$) of the three. The least representative at all scales was the Extreme Value Function. It overestimated the species richness for any given area by a mean error of 42%. This function was concluded to be severely limited in its application because it assumes random distribution of species within the habitat, therefore, any habitat with physical or temporal boundaries limiting movement of species would be severely misrepresented.

The wandering porcupine: Seasonal differences in home range use in a northern vs. southern population (P)

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In order to determine the possible importance of northern climes on movement and seasonal foraging behaviour of North American porcupine (*Erethizon dorsatum*) this study compares home range uses within Central Labrador. Another goal was to add a northern context to current understanding of porcupine population dynamics. From September 1999 until February 2001, 18 radio-collared animals were followed and relocated. ArcView GIS was used to display the locations on digitised topographical maps in order to calculate for each porcupine 'winter' and 'non winter' home ranges based on the Minimum Convex Polygon (MCP) method. Of the 18 monitored porcupines, 11 produced sufficient data to estimate their seasonal home ranges. All showed a significant

difference between 'winter' and 'non winter' range uses. This finding leads to the second question, whether these seasonal changes are of similar magnitude to southern geographic sites. Hence, Labrador data were compared to data from Roze (1987) that were collected in N.Y. (1982-1985). The comparison of the two studies showed only a significant difference between northern and southern 'non winter' home ranges. It is possible that due to snowfall in both winter locations the winter ranges did not differ significantly.

A comparison of microsatellite variability in two subspecies of black rhinoceros, *Diceros bicornis minor* and *D. b. bicornis* and an evaluation of these loci for in situ paternity studies in *D. b. bicornis*. (P)

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The black rhinoceros (*Diceros bicornis*) has suffered a severe population bottleneck and its current range is highly fragmented. Although they have experienced different recent histories, the variation in genetic diversity among the three *D. bicornis* subspecies has been poorly characterized. Another shortcoming is the absence of data on the in situ mating system of any of the *D. bicornis* subspecies. Both of these data are important when planning conservation and management initiatives for the remaining black rhino populations. Using polymorphic microsatellite DNA we: 1) quantify the difference in microsatellite variability between *D. b. minor* and *D. b. bicornis* and 2) evaluate these markers for paternity assignment in free ranging *D. b. bicornis* from Namibia. We compare the genetic variability of four polymorphic microsatellite loci between *D. b. minor* (N = 14) and *D. b. bicornis* (N = 27) (HetAvg = 0.7032± 0.0777). We then evaluate these four loci, in addition to one published locus, for their ability to accurately determine paternity. The genotypes of 27 *D. b. bicornis* individuals from three regions of Namibia are coupled with complete or partial pedigree information and paternity is assessed using two specific analyses: 1) probability of exclusion, and 2) exclusion-likelihood based CERVUS software. Results are to follow.

Sounding out fish: the distribution and abundance of whitefish near Douglas Point, Lake Huron (P)

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Although the Bruce Nuclear Power Development (BNPD) has operated on the eastern shoreline of Lake Huron for 30 years, the impact(s) of this facility on whitefish in the main basin have never been formally investigated. We began a 3-year project in 1999 with the goals of (1) determining the most practical gears and survey designs and (2) demonstrating credible links between the BNPD and whitefish population response for any recommended assessment program. In November 2000 we surveyed a 140 km² area around Douglas Point hydroacoustically while conducting concurrent validation gillnetting at 8 locations to determine if lake whitefish (*Coregonus clupeaformis*) and round whitefish (*Prosopium cylindraceum*) are present near the BNPD during the fall spawning period and to assess the practicality of hydroacoustic technology. Daytime surveys generally found small tight aggregations of fish scattered throughout the survey area near the bottom. During the nighttime there were few aggregations and biomass estimates were about twice as high compared with estimates along the same transects during the day. Gillnet data are consistent with the hydroacoustic data in that daytime sets were largely ineffective, with CUE (number/16 hrs fished) ranging from 0 (4 sets) to 60.4 (1 set). During nighttime sets fish abundance was higher with CUE ranging from 8.2 to 162.5 individuals/16 hrs fished. Acoustic estimates of pelagic and benthic fish biomass tended to increase from north to south and is consistent with overall fish abundance and whitefish abundance in day and nighttime gillnets. The finding that these datasets exhibit similar north-south trends provides validation of the hydroacoustic sampling and supports the conclusion that the observed pattern of biomass

distribution is real and may be related to lake whitefish behaviour.

Fast and hot: What drives development rate in turtles? (P)

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Developmental models are used to predict the development stages of many plant and insect species. In my M.Sc. research, I developed and evaluated a model for turtle embryonic development ($s=k_0 + k_u u(t) + k_t t$) using the common snapping turtle (*Chelydra serpentina*) as a study species. Results showed that developmental stage, s , was a function of accumulated heat units within a nest, $u(t)$, and time since oviposition, t , in this species. In order to generalize for all turtles, I have tested the model for a second species: the painted turtle (*Chrysemys picta*). Results confirm that the amount of heat to which an egg is exposed, s , and time since oviposition, t , are both important to the development of painted turtle embryos. Because snapping turtles and painted turtles are taxonomically distant (different families) these results suggest that development in many species of turtles may be regulated by both temperature and incubation time. Such developmental growth models can be used to determine the developmental factors limiting this species distribution and to determine the effect of temperature on sex under naturally fluctuating temperatures.

A longitudinal study of the invertebrate and fish communities in riffles of the middle reaches of the Grand River, Ontario (P)

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Since the late 1980's, the middle reaches of the Grand River have been stocked with hundreds of thousands of brown trout (*Salmo trutta*). While intensive stocking has produced an exciting sport fishery, the long-term goal of the partners involved in managing the fishery remains the establishment of a self-sustaining population of naturally reproducing brown trout. The viability of the game fish population depends in part on the nature of the overall biotic communities of the relevant reaches of the river, including both the aquatic invertebrates and the other fishes. Beginning in 1997, triplicate samples of invertebrates from the riffles of 16 stations, from the Shand Dam to West Montrose, have been collected. Correspondence analysis of a subset of these samples (those collected in late summer of 1997 and 1999 from 10 of the original stations) reveals an orderly longitudinal change in the communities as one moves downstream from the Shand Dam. Detailed analysis indicates changes in taxon richness and overall abundance, as well as changes in the dominant taxa. The fish communities of the riffles of the 16 stations were sampled in the fall of 2000. Both classification and ordination indicate that two distinct types of fish communities, separated longitudinally, are present. The characteristic species of the upriver community type is the yellow perch (*Perca flavescens*) and of the downstream type, the rainbow darter (*Etheostoma caeruleum*). These analyses of the invertebrate and fish communities indicate that the overall communities upstream of the Elora Gorge are quite different from the communities downstream.

Parallel divergence of four Icelandic lacustrine population of threespine sticklebacks (*Gasterosteus aculeatus* L.) towards two unique bottom types. (P)

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In the past decade there has been increased interest among scientists on the ecology and evolution of diversity in morphology, physiology and behaviour within species. Freshwater fish are particularly interesting in this respect. Icelandic freshwater systems have highly diverse habitats with only six species of freshwater fish, offering unique opportunities to study the evolution of this diversity and how it can be related to speciation. Elsewhere, research has shown threespine sticklebacks to be highly variable in morphology, physiology and behaviour. In some cases it has led to the formation of new species. Sticklebacks have a short generation time and are easily kept and bred in laboratory. Icelandic sticklebacks are highly diverse with indications that two distinct forms, adapted to two different habitats, occur in several lakes. This makes the sticklebacks a good candidate for studying morphological adaptations. Icelandic threespine sticklebacks show parallel morphological differences related to mud and lava habitats in four Icelandic lakes. The level of morphological diversification varies among the lakes, ranging from a population with a wide morphological distribution to a population with clear resource morphs, where the diversification was represented in diet differences. These different levels of divergence represent the differences in the ecological surroundings each population experiences. The results of this study will provide further understanding on how distinct ecological factors influence the adaptations of animals. Such a process is important for the understanding of the origin of biological diversity.

Of mice, mothers and mirror images: Testing the relationship between fluctuating asymmetry and fitness in a long-term collection of deer mice (*Peromyscus maniculatus*) (P)

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Fluctuating asymmetries are small, random, deviations from perfect bilateral symmetry that are the hypothesized consequence of imperfect regulation of development. Recently, fluctuating asymmetry has been suggested as a tool for monitoring levels of ecological "stress" within and between populations, as well as over time. However, there remains much scientific debate over the validity of the theoretical relationship that exists between asymmetries and fitness. We tested this relationship using a long-term collection of deer mice, *Peromyscus maniculatus*, from Algonquin Park, Ontario, where the population has undergone dramatic fluctuations. Distances between landmarks on pairs of dentary bones were obtained. This data was used to generate estimates of individual and population-level asymmetries, which were compared to female fitness correlates and to inter-annual changes in mouse density, respectively. Results of these analyses and the implications to fluctuating asymmetry use in conservation biology will be presented and discussed.

The effect of cool incubation temperatures on hatchling snapping turtles (*Chelydra serpentina*) (P)

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The effect of cool incubation temperatures on hatchling snapping turtle (*Chelydra serpentina*) mortality and

survivorship was examined in this study. Thirty-six eggs were collected from each of 28 different nests in Algonquin Park, Ontario. To minimize bias due to genetic effects, one third of each wild clutch was placed in each of three treatment sites composed of 10 artificial nest clutches per treatment. Cold, medium and hot treatment sites yielded total heat unit accumulations equivalent to constant temperature ranges of 20-22 °C, 23-25 °C and 25-27 °C respectively. A repeated-measures ANOVA was used to analyze the data and a Bonferroni's and Mauchley's test of sphericity was used to correct for maternal effects and the overlap in variances. The percentage of successful hatching was significantly lowest in the cold treatment site at 54.2%, and significantly highest in the occurrence of lethal deformities (74.2%) and overall deformities (44.1%). Hatchlings incubated in the cold treatment group also experienced the greatest number of deformities per hatchling (2.29 ± 0.24). Both the medium and hot treatments did not differ significantly from each other and overall, experienced a higher hatching success and lower occurrence of deformities compared to the cold treatments.

Impacts of low-head dams on sea lamprey and nontarget fishes in Great Lakes streams (P)

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Low-head dams are a potential control technique for parasitic sea lamprey, *Petromyzon marinus*, in tributary streams to the Laurentian Great lakes. They block upstream migration of spawning adults. We investigated the impacts of low-head dams on nontarget fishes using: (i) historical records of fish distributions, (ii) comparisons of fish communities in matched pairs of streams with low-head dams and reference streams, (iii) estimation of movements of marked fishes in matched pairs of streams, and (iv) comparisons of fish communities in streams with low-head dams to streams with natural barriers. There are fewer fish species in stream sections upstream of and Below dams are lower than corresponding sections of reference streams. Similarity indices comparing sections Above species across low-head dams are impeded. If low-head dams can be regulated on a seasonal basis this impact could be reduced. Low-head dams have little effect on fish species community size composition. Abundance of some nontarget fish species are increased above low-head dams. Native lampreys appear to derive protection in these areas. The magnitude of the impacts for low-head dams is comparable to that for natural barriers. Low-head dams do have some impacts on nontarget fishes. Impacts on nontarget species may be reduced by modifications in design and operation of dams.

Growth and sexual development in the self-fertilizing hermaphroditic mangrove killifish (P)

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The self-fertilizing mangrove killifish, *Rivulus marmoratus*, is unique among vertebrates. We validated otolith age and growth techniques in fish of known age. Feed restriction reduced the number of otolith growth increments. A few individuals develop and mature as primary males, and remain so throughout their lives. Most individuals first develop ovarian tissue, apparently to a state of maturity. They subsequently develop testicular tissue and become functional hermaphrodites. Later in life some hermaphrodites lose ovarian tissue from their gonads and become secondary males. We propose that this pattern of sequential hermaphroditism can account for the genetic

constitution known from wild populations of this species. Most individuals result from self-fertilization, but in some populations some individuals result from sexual crossings between individuals. We predict that sexual crossing between individuals most likely occurs between young females and either primary or secondary males.

Hutchinsonian ratios in shorebirds: Artifact or assembly rules? (P)

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Theories suggesting that morphological character ratios contribute to the structuring of communities have been hotly debated by ecologists. Some hypothesize that observed character ratios are an artifact of statistical distributions, while others argue that they result from size-assortative species' assembly rules, to maximize niche packing in limited resource space. My objective was to determine if differences in bill length among species of shorebirds mediated competition during spring and/or fall migration at Presqu'ile Provincial Park. I predicted that if competition occurred between species of shorebirds, then species similar in bill length should coexist less often than expected by chance relative to species dissimilar in bill length, which should coexist at random. Also, the degree of structuring of the assemblages should vary depending on resource availability. To test this, for each week during spring and fall migration, I compared the probability of co-occurrence of each species pair of shorebirds expected by chance in replicated sections of beach, to the observed co-occurrence of each species' pair. Also for each week, I calculated the bill length ratios of all species' pairs and determined whether each was greater or less than the average. Chi-square was used to determine whether the probability of coexistence of species was independent of bill length ratio. In 8 of 9 weeks, the probability of co-occurrence was independent ($p > 0.05$) of differences in bill morphology, suggesting that there was no competition for food among shorebirds during either spring or fall. Consistently, there was no correlation ($p >> 0.05$) between resource availability and the extent to which community structure deviated from random. These results do not speak directly, however, to the issue of whether observed size ratios in communities are artifacts or the result of species' interactions, since neither consistent size ratios, nor resource limitation, were observed each week.

East meets west: The cold water stream war over spawning rights in Wilmot Creek (P)

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Atlantic salmon (*Salmo salar*) were extirpated from Lake Ontario just prior to the start of the 20th century. Several attempts to re-establish this species in Lake Ontario have had no, to negligible success. Numerous changes to the Lake Ontario system since the arrival of European settlers to the region (some of which contributed to the demise of Atlantic salmon in Lake Ontario in the first place whereas others have taken place since extirpation) have been hypothesized to contribute to the past failure of re-introduction attempts. Current restoration efforts focus on identifying factors that may impede the success of future re-introduction programs. Here, we examined interactions during the fall spawning interval between adult Atlantic and chinook salmon, which are native to the Pacific Coast of North America and were introduced into Lake Ontario to enhance sport fishing opportunities. A removal experiment showed that Atlantic salmon were much more active in the presence of chinook salmon than they were when they were alone. Furthermore, Atlantic salmon were in poorer condition, initiated nesting later, and survived less well when chinook were present than when they were absent.

Nest site selection in the wild by cultured Atlantic salmon. (P)

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The current programme to reintroduce Atlantic salmon (*Salmo salar*) to the Lake Ontario ecosystem uses a strain of fish that has been in the hatchery system for many generations. Such conditions of relaxed natural selection have been implicated in the loss of important behavioural traits associated with reproduction across a variety of cultured salmonids. Here, we examined nest site selection by female Atlantic salmon released into Wilmot Creek, locations that were under-represented by very large and very fine substrate and over-represented by moderately large substrate relative to substrate composition of random sites available in the stream. Nests were found in sites with moderate depth relative to available stream depths. Stream current did not seem to matter in nest site selection. Values of the variables used by the hatchery strain of Atlantic salmon match values that impart high embryo survival.

Growing alternative greenhouse crops in hydroponics (P)

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In North America, the use of medicinal plants as an alternative to conventional medicine has increased dramatically. As a result, the interest in the production of medicinal plants from greenhouse growers has risen in the past few years. However, practically no information on the commercial production of medicinal plants in greenhouses exists. Thus, this research project attempts to grow medicinal plants in the greenhouse environment proven therapeutic effects and/or high market potential, 2) nutritional needs, 3) feasibility, 4) crop scheduling, 5) susceptibility to disease and pests, and 6) levels of active constituents. Greenhouse practice has identified three commonly used basic nutrient solutions where the ratios of some macronutrients are adjusted. The three solutions have progressively increasing levels of nitrogen, potassium, calcium, and magnesium. A number of medicinal plant species were grown in these solutions. In all cases the intermediate solution yielded the best results. The leaves of *Hypericum perforatum* and *Tanacetum parthenium* contain the medicinal constituents of interest. Since, nitrogen is known to contribute greatly to the vegetative growth of plants, a second experiment was conducted in which only nitrogen concentration was varied (60, 120, 180, and 240 ppm). For *Hypericum perforatum*, the highest nitrogen level yielded the least amount of target tissue. No significant differences were found among the treatments for *Tanacetum parthenium*.

Optimization of growth, yield and quality of active constituents of the medicinal plant *Calendula officinalis* L. (P)

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Eighty percent of the world's population depend on traditional herbal medicines and the North American market is growing rapidly. However, there is a strong public and regulatory demand for elevated quality and uniformity of medicinal plant products. Controlled climate greenhouse hydroponic cultivation allows for contaminant and pesticide-free conditions, resulting in greater product quality and consistency. *Calendula officinalis* (Asteraceae),

the common pot marigold, is an annual flowering plant that is traditionally used as an anti-inflammatory agent (Akihisa et al. 1996). My work attempts to increase flower yield and secondary metabolite production through various factors. Phosphorus is an important plant nutrient, particularly during flower production, but it is often limiting in natural ecosystem (Raghothama 2000). Increasing phosphorus allows increased inflorescence production, as well as secondary metabolite production (Feller, 1995). The control of nutrient supply in hydroponic culture is critical for optimal plant growth. Conventional solution culture techniques often provide large volumes of solution with nutrient concentrations, higher than found naturally. Those techniques that allow nutrient depletion by plants before complete solution replacement often result in deficiency symptoms and fluctuations in growth rate (Stadt, 1991). The nutrient supply rates used in this study correspond to the native habitat of the species. The medicinal plants were also subjected to simulated foliar herbivory, as numerous studies have shown that herbivory can induce increased growth due to overcompensation (Agrawal, 2000) and stimulate secondary metabolite production (Collantes et al. 1996). The effects of these variables on leaf and flower yield, and plant height will be discussed.

The effect of traffic noise on bird abundance in the dairy bush (P)

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Contrasting views exist regarding the effects of traffic noise on bird abundance; the majority of these views suggest that abundance is negatively influenced. This study examined the effects of traffic noise on bird abundance in the Dairy Bush, Guelph Ontario. The western half of the Dairy Bush was divided into 3 sections, close, medium and far, in relation to distance from a high traffic roadway. Three point counts were randomly chosen in each of the sections. Observations took place between 07:45 and 09:00 on weekdays (morning rush) and weekends (control). Bird abundance (all species) and sound levels (decibels) were recorded at each of the point counts. Sound levels were significantly different between weekdays and weekends ($p < 0.0001$), as well as between sections ($p = 0.002$). Bird abundance was significantly different on weekdays ($p = 0.009$). No correlation was found between mean sound levels and mean abundance for each point count (weekday, $p = 0.235$, weekend, $p = 0.351$). Mean values of each section (close, medium, far) for sound and abundance do show a correlation on weekends ($p = 0.003$, $r^2 = 0.998$). Evidence does suggest that traffic noise has a negative influence on bird abundance. It is speculative that automobile noise distorts bird vocalizations, leading to reduced reproduction and increased emigration from high noise areas.

Sexual selection, parental investment and human mate choice (P)

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This study examines the predictions and applications of the parental investment model to human mating relationships. As defined by Trivers (1972), parental investment is defined as any input of resources into a particular offspring which increases the survival of the offspring, but also decreases the ability of the parent to invest in other offspring. In the current study, male and female participants (468 undergraduate students from Brock University, 134 males and 333 females) rated their minimum requirements in a partner at various levels of relationship: single date, one-night stand, casual dating, steady dating, and marriage. The levels of relationship are hypothesized to reflect increasing risk of parental investment. The predictions of the parental investment model indicate that males should display significantly lower requirements than females, due to the lower parental investment required of males. Additionally, as risk of parental investment increased, the requirements of both males and females should increase. Results of the analyses support the predictions of the parental investment model in relationship to sex differences.