My Career in Mathematical Biology
A Personal Journey

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How does an urban-born-and-reared kid from Philly wind up being an ecologist who's had the pleasure to use mathematics to delve a bit into the mysteries of panthers, bears, gators, raccoons, ramps, savannas and strawberries? Gather round, and I'll spin a tale of joyful collaborations, of posing difficult questions, and invigorating mentoring, liberally sprinkled with music and dance (the latter to ensure some semblance of sanity). As all such tales do, it begins at home, as I am extremely lucky to have parents who have continually encouraged me to think for myself: "The good Lord gave you a brain, Louis, now use it!" being a regularly heard mantra from my electrical engineer father. My mother is still my mentor in culinary adventures, and I have somewhat mastered the art of pie making.

My personal journey has benefited from those amateur naturalists and scout leaders, bus drivers and metal workers by occupation, who instilled in a young teenager the wonder and great diversity of natural history even in the urban confines of Philadelphia. Much of what I know about observational science arose from the mentoring of astronomers, notably Bruce Balick and John Wardle, while I was a Drexel University undergraduate cooperative education student at the National Radio Astronomy Observatory. My first attempt to contribute to new science was applying maximum entropy methods to radio interferometry data, and it is pleasing to see that thirty years later, similar conceptual approaches are being applied to species spatial distributions.

Mathematics mostly came easily to me at Central High, where I had my first chance to try my hand at teaching as a Student Tutor and giving many planetarium talks. My first taste of the great potential for mathematics to contribute to biology came from Charles Mode while I was an undergrad at Drexel, going through much of his book on stochastic processes applied to human demography that was published in the Springer "green book" math biology series. Simon Levin, whose enormous energy and boundless enthusiasm for the utility of quantitative approaches to both theory and application in biology, guided me through the rigors of a true applied math Ph.D. (e.g. for me, good applied math is also good science). It was Simon and my great colleague Tom Hallam at Tennessee from whom I learned the fine and gentle art of mentoring students and postdocs. My collaboration with Simon and Tom in developing and leading the long series of courses and workshops on mathematical biology for developing country scientists at the Abdus Salam International Centre for Theoretical Physics in Trieste has been one of the joys of my career as well as perhaps the most important teaching I have done.

Careful attention from Brian Chabot at Cornell introduced a very naïve mathematician to biological experimentation and my first lab and field experience in Brian's ecology of strawberries research. With a heavy exposure to differential equations and stochastic processes, I came into the core graduate ecology course sequence at Cornell unprepared biologically, but trying to place the topics in the context of dynamical systems. The marvelous regular seminars that Simon led provided a perfect jump-off point beyond the inherent focus on dynamics in the population ecology (and to a lesser extent, community ecology) of the time. I was struck by the lack of this perspective in much of physiological ecology, and given my antipathy towards blood and guts, plant biology beckoned.

Since it is perhaps the most basic life process, I had assumed that photosynthesis would be well understood. When it was clear that little information was available on the dynamics of photosynthetic response at leaf level, this became my entrée to lab (and abortive field) experiments to parameterize models. The underlying question was "does dynamics matter" to whole plant carbon gain, and my pulse and step-response to light change experiments required a model to tease apart instrument response from biological signal and then parameterize a differential equation for net carbon gain. From this I gained, in addition to a dissertation, a great deal of respect for the intricacies of lab work. When I moved to join Tom Hallam's efforts in the Math Department at Tennessee to develop a program in math biology, it rapidly became clear that building a lab was not feasible. Thus began a wonderful collaboration with Bob Pearcy of UC Davis to incorporate realistic plant physiology into dynamic carbon gain models. Bob's great ecophysiology insight and laboratory expertise guided development of models that really did allow us to elucidate situations in which photosynthetic dynamics mattered.

My long-time colleague Don DeAngelis introduced me to the potential for individual-based approaches to contribute new insight to population dynamics and it has been a pleasure to watch the continuing expansion of this approach applied in many areas of biology and social science. Don and I instigated the ATLSS (Across Trophic Level System Simulation) project which consumed much of a decade of my career in developing a rational scientific basis to elucidate potential responses of the biota to alternative Everglades restoration scenarios. The challenges in linking diverse models with differing scales and underlying mathematical and computational forms, which we called multimodeling, were evident from the start. Happily, we gathered an amazing group of students, postdocs and collaborators who together managed to provide what wound up being essentially the only input on biotic impacts to the planning for this enormously expensive enterprise. Along the way, I learned a bit about the Florida panther (and associated issues of malfeasance in science), gators, savannas, and wading birds.

Everglades planning could be viewed as an extremely complex spatial optimization problem, and out of this came another major theme of my research efforts, spatial control for ecosystem management. Along with Suzanne Lenhart and Michael Berry and an outstanding set of students and postdocs with diverse backgrounds, we developed new mathematical and computational schemes for natural resource management, asking what to do, where to do it, when to do it, and how to assess success. We built new algorithms to parallelize models to make this computationally feasible (with Dali Wang). This led to applications to tick-borne disease (with Holly Gaff), preserve design for black bears accounting for human-bear interactions (with René Salinas), endangered population augmentation (with Erin Bodine) and wildfire control. Brian Beckage and I started our long-standing set of collaborations in plant biology by evaluating harvest data on ramps (wild leeks), the analysis of which led the Great Smoky Mountains National Park to change their policy on harvesting ramps.

It was John Jungck whose leadership of the BioQuest project encouraged me in the early 1990's to focus attention on the need for a new view of undergraduate quantitative life science education. This led to my leadership and participation in many educational workshops and reports and visits to numerous institutions to encourage an integrative view of quantitative learning that is not focused solely on a calculus course, but infuses math throughout the biology curriculum. I wholeheartedly embrace the transformation of math for life sciences away from anectodes and towards a scientific approach to evaluating impacts of our teaching.

If anything, I have acted as an instigator and team cheerleader to encourage efforts of those trained in math and computer science to collaborate with biologists and encourage the development of a cadre of individuals who have mathematical and biological intuition. This led naturally to NIMBioS and many projects which demonstrate how an integrative view of natural systems is useful in a variety of biological contexts. I expect that a goodly portion of the advances in biology over the next decades will arise from an integrative view of systems from the sub-cellular level to that of organisms to that of regional-scale issues. Such integration requires careful modeling and applications of mathematics and computational science.

My scientific and educational endeavors have been tremendous fun. However what sanity I have maintained throughout a rather hectic schedule has been due to the great pleasure I have received from my arts and music friends, notably my wife Marilyn Kallet whose poetry sings to so many and my daughter Heather Gross whose music has lit up so many of my days. My life has been enormously enriched by their talents and by those of the many musicians, writers and dancers who have befriended me over the years.

Selected publications are available at www.tiem.utk.edu/~gross/ and please view NIMBioS.org for many opportunities at the interface of math and biology.