Pork chops, carrying capacity, and cumulative effects

by Steve Oberle, Ph.D.

You may be asking yourself, what do pork chops and the concepts of carrying capacity and cumulative effects have in common? Let me explain.

The main "by-products" of our livestock (eg. dairy, hogs, poultry) production are manure and process wastewater. Over time, especially in regions and watersheds with high densities of larger-scale livestock farms and concentrated animal feeding operations (CAFOs), excessive amounts of plant nutrients (eg. nitrogen, phosphorus) are added to farm fields with consecutive (eg. annual, biannual) manure and wastewater applications, especially on fields adjacent and nearest to the production area(s). In some cases, multiple facilities are spreading on the same fields.

Use of livestock manure to enhance soil fertility and to promote plant health and proper plant nutrition are sustainable agricultural practices. Use of the land as a means of livestock waste disposal is not only unsustainable; it is a direct threat to the groundwater, surface water, and health/safety of everyone downstream. In other words, excessive plant nutrient applications (loading) to farm fields (soils) from livestock manure, process wastewater, and synthetic fertilizers makes no agronomic, economic, or environmental sense.

Put another way, in the words of the University of Wisconsin's nutrient recommendation program, the "optimum" level of plant nutrients in soils (fields) is "economically and environmentally the most desirable soil test category," and "yields are optimized at nutrient additions approximately equal to amounts removed in the harvested portion of the crop. There is no profit in applying nutrients that will not be used."

Now the only explanation one is left with for these excessive nutrient applications to farm fields is that (in general) many livestock producers choose to treat their manure as waste, and the land (soil) as their means of waste disposal. And undoubtedly there are several reasons for this including the massive quantities of manure and process wastewater produced, especially with larger-scale and CAFO-sized operations; the associated excessive amounts of plant nutrients generated relative to actual plant (crop) needs; limited land base available/used for spreading purposes; and storage, transportation, and spreading costs.

So one may ask, what are the short- and longer-term consequences of all of this resource/waste material going on the land in our watersheds, or even next door to our home and/or private well? And what are the likely impacts to the land, to the groundwater and surface water, and to human health and safety? In my own research and work with the public on these matters, I have found the that the concepts of carrying capacity and cumulative effects come in really handy when making sense of, and confronting, these issues/problems.

The concept of carrying capacity is a relatively old one and, in a general sense, can be defined as the maximum population size (of a particular species) that the environment can sustain indefinitely. In the context of agriculture, this concept can be applied at many levels including watershed, farm, and field. In fact, the concept of carrying capacity can easily be extended to the soils (within a particular field) level. And this is where it mostly applies to the issues around excessive livestock waste spreading in and around our landscapes, watersheds, homes, and wells.

So just as a field has an associated carrying capacity for crops and/or livestock, soils have a carrying capacity for plant nutrients. And one could argue that the soil types within a particular field are a primary factor in determining the carrying capacity of that field. Many have recognized that good soil fertility is a key to our longevity as a species, when you consider that soil fertility is the capacity of the soil to sustain life (eg. microscopic to humankind).

Although the concept of carrying capacity is usually framed in a biological (eg. population, species) context, as it pertains to agriculture and crop/livestock production, one must also consider the soil and chemical aspects of these land uses. In this context, the concept of carrying capacity refers to the capacity of a particular soil, and in turn field, to carry (hold) plant nutrients. If our soils were not able to carry or hold plant nutrients, it would be impossible to grow the crops (feed) necessary for livestock production, which in turn would limit populations (ie. crops, livestock, people) a particular field (soil) could support. Thus, the carrying capacity would be limited.

In the cases where there are massive quantities of livestock wastes (and the associated excessive amounts of plant nutrients) going on fields, the end result is that the capacity of the soils associated with these fields to carry (hold) all of these nutrients, is quickly exceeded. Put another way, a particular soil, and in turn field, will have a much lower "carrying capacity" for additional plant nutrients (from consecutive livestock manure-wastewater and fertilizer applications) when nutrient levels are already excessively high; and far in excess of crop (plant) demands.

And it's mostly in these cases where I would expect to see relatively high nutrient (eg. nitrogen, phosphorus) losses from fields, in some cases over a considerable period of time. And in turn, in some cases, severe degradation of groundwater and surface water quality downstream, especially down gradient from fields adjacent and nearest to production area(s), and/or fields that are being spread on by multiple facilities.

So, where does the concept of cumulative effects come in? Cumulative (environmental) effects can be defined as effects on the environment (at any scale) which are caused by the combined results of past, current, and future activities – in this case, agricultural activities. To get a better handle on the concept of cumulative effects as it applies to agriculture and carrying capacity, one must consider these land use/management activities (and the resulting environmental impacts) at scales larger than field and farm (eg. watershed).

Cumulative effects analyses of CAFO-sized livestock operations at larger scales (eg. watershed, region) reveals that the impacts to groundwater and surface water, especially in regions with high densities of (or improperly-sited) facilities, can be devastating (note attached graphics). Environmental indicators of this include, but are not limited to, nutrient/sediment plumes, algal blooms, and dead zones (hypoxia) in surface waters; nitrate, manure/wastewater, phosphorus, bacteria, viruses in groundwater and private wells.

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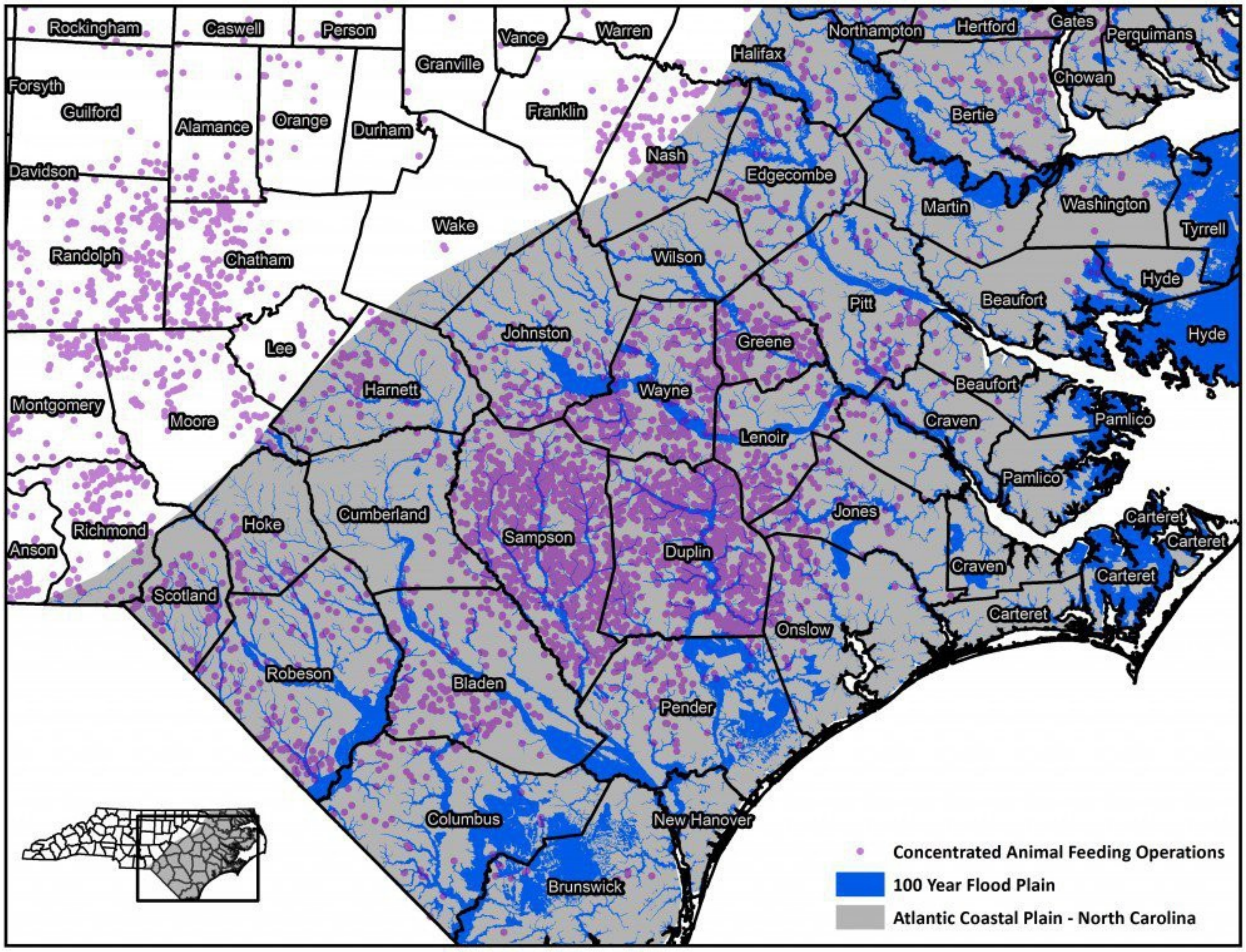
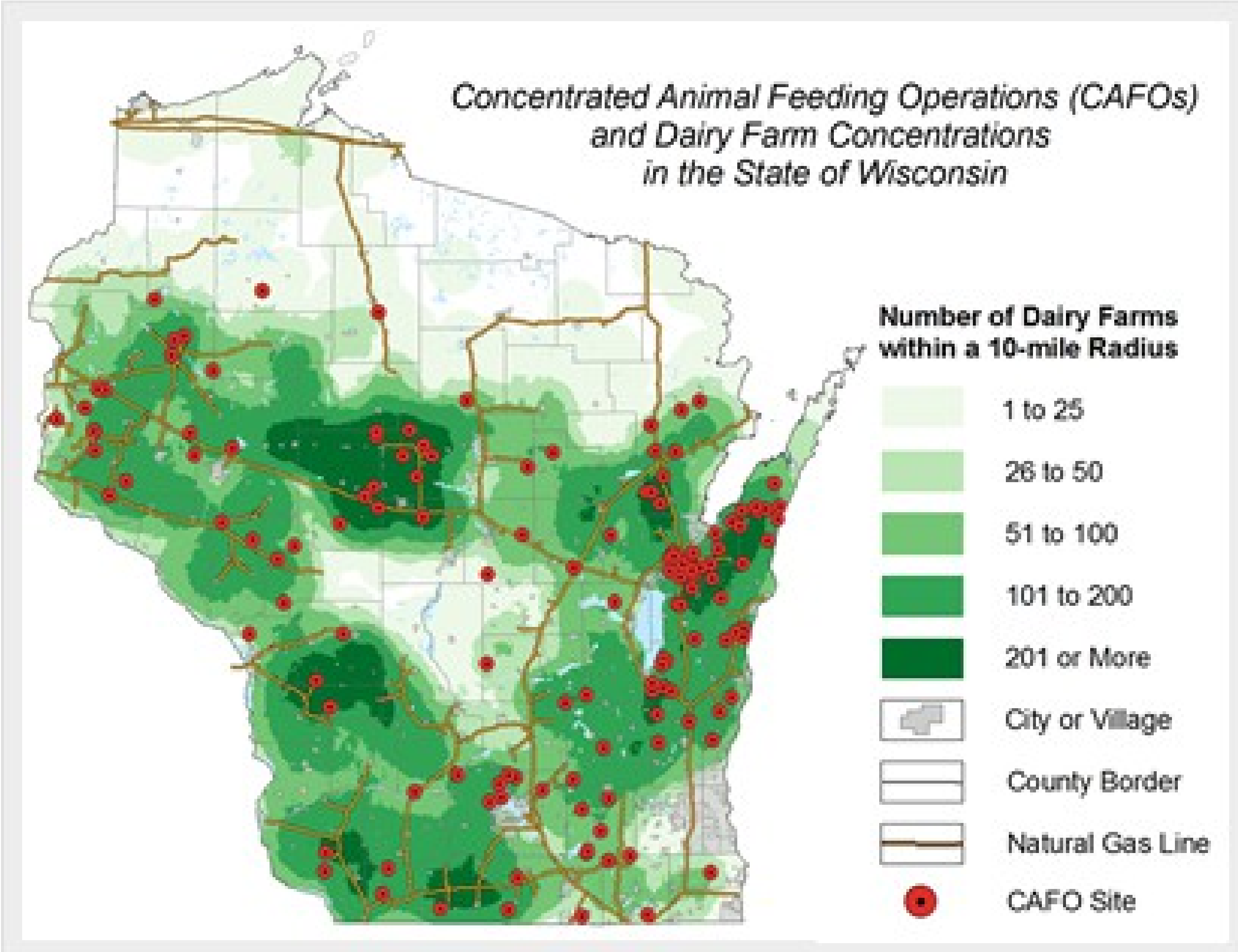


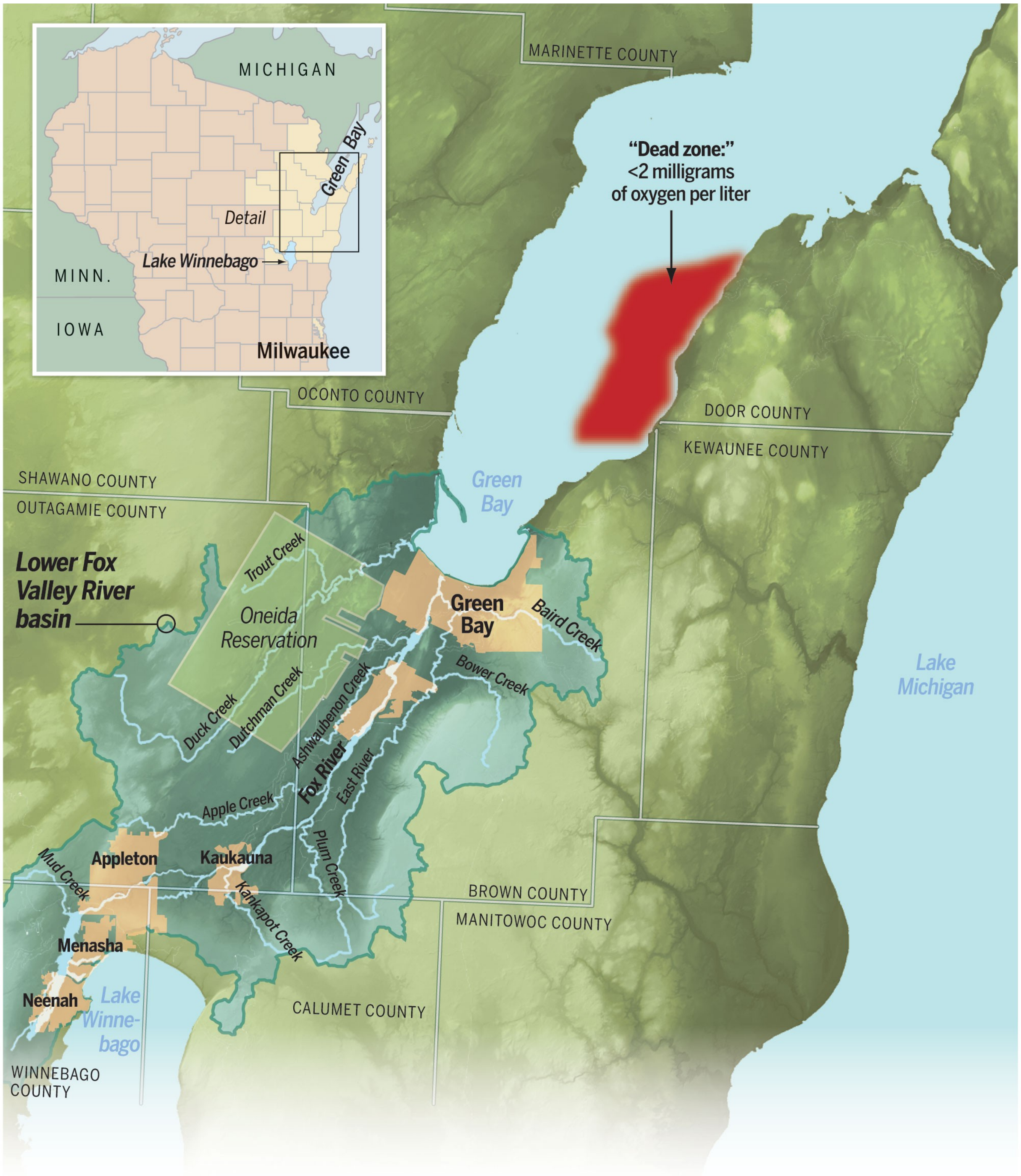
North Carolina CAFO and Flood-Coastal Plain Map

Neuse-Tar-Pamlico Rivers (North Carolina) nutrient/sediment plumes (precursors of, and fuel for, hypoxia)



Wisconsin CAFO and dairy farm concentrations

Green Bay (Lake Michigan) algal bloom



Green Bay (Lake Michigan) hypoxia (dead zone)

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