

Ecological and Human Health Issues

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Four issues

- 1. Environmental consequences of “industrial” terrestrial animal production**
- 2. If aquaculture is agriculture, what is the model for it’s growth?**
- 3. Aquaculture’s dependence on capture fisheries**
- 4. Healthfulness of farmed fish**

Old MacDonald no longer has a farm.





“Cities of Animals”



Hog waste typically sprayed onto
fields.....



“Cities of animals”, because:*

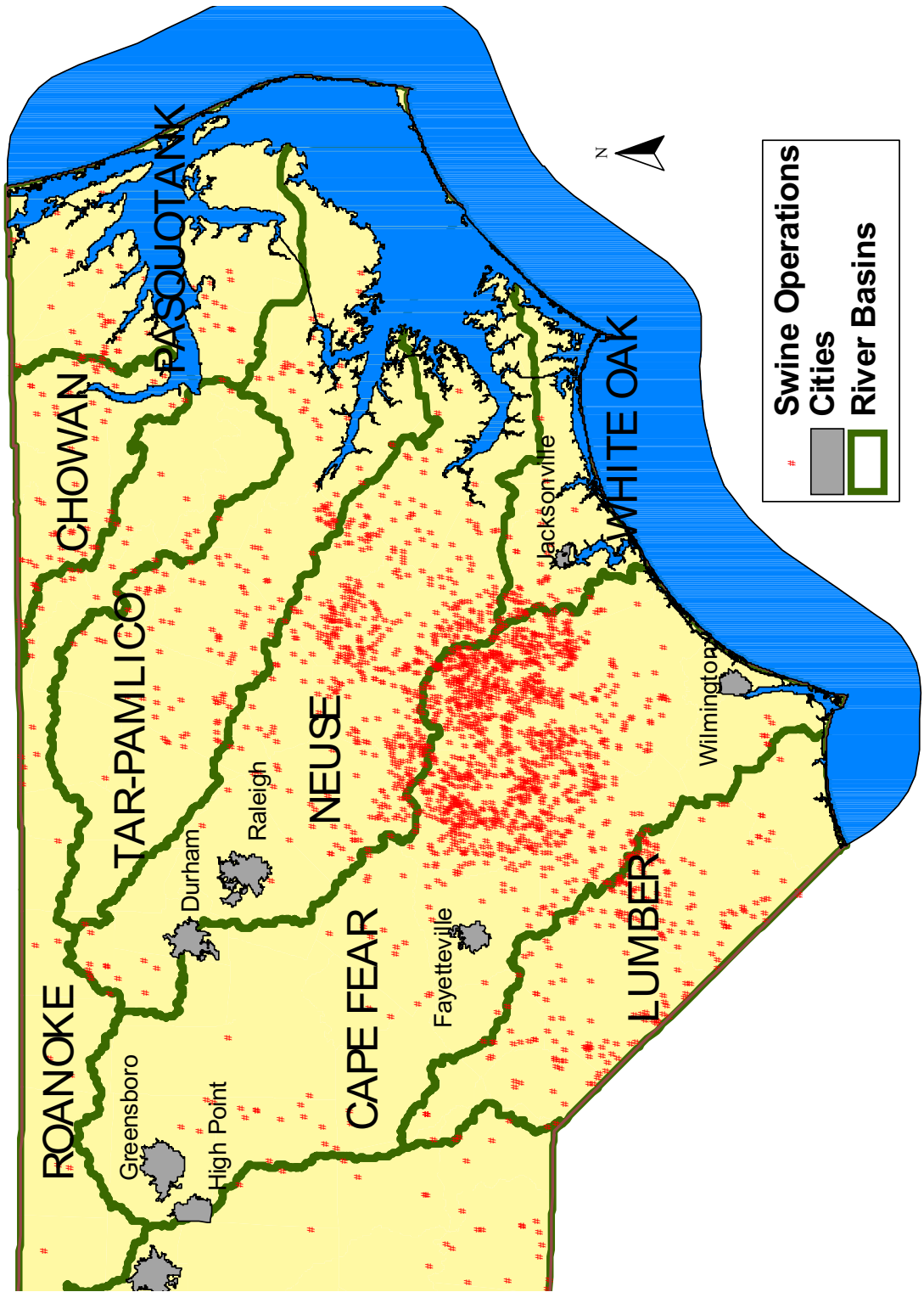
- **Microeconomics: Economies of scale**
- **Diet management**
- **Product quality control**
- **Ease of handling**
- **Macroeconomic factors: Markets, Finance, Politics**

* Courtesy of Larry Cahoon, UNC Wilmington

Regional Concentration: A “Metropolis of Animals”

- **Large confined animal feeding operations (CAFO’s) must import feeds**
- **Feed quality/quantity require large mills**
- **Proximity to mills lowers transport costs**
- **Proximity to packing plants lowers costs**
- **Rural areas w/cheap land, low population**
- **Limited regulatory obstacles**
- **Economic and political power**

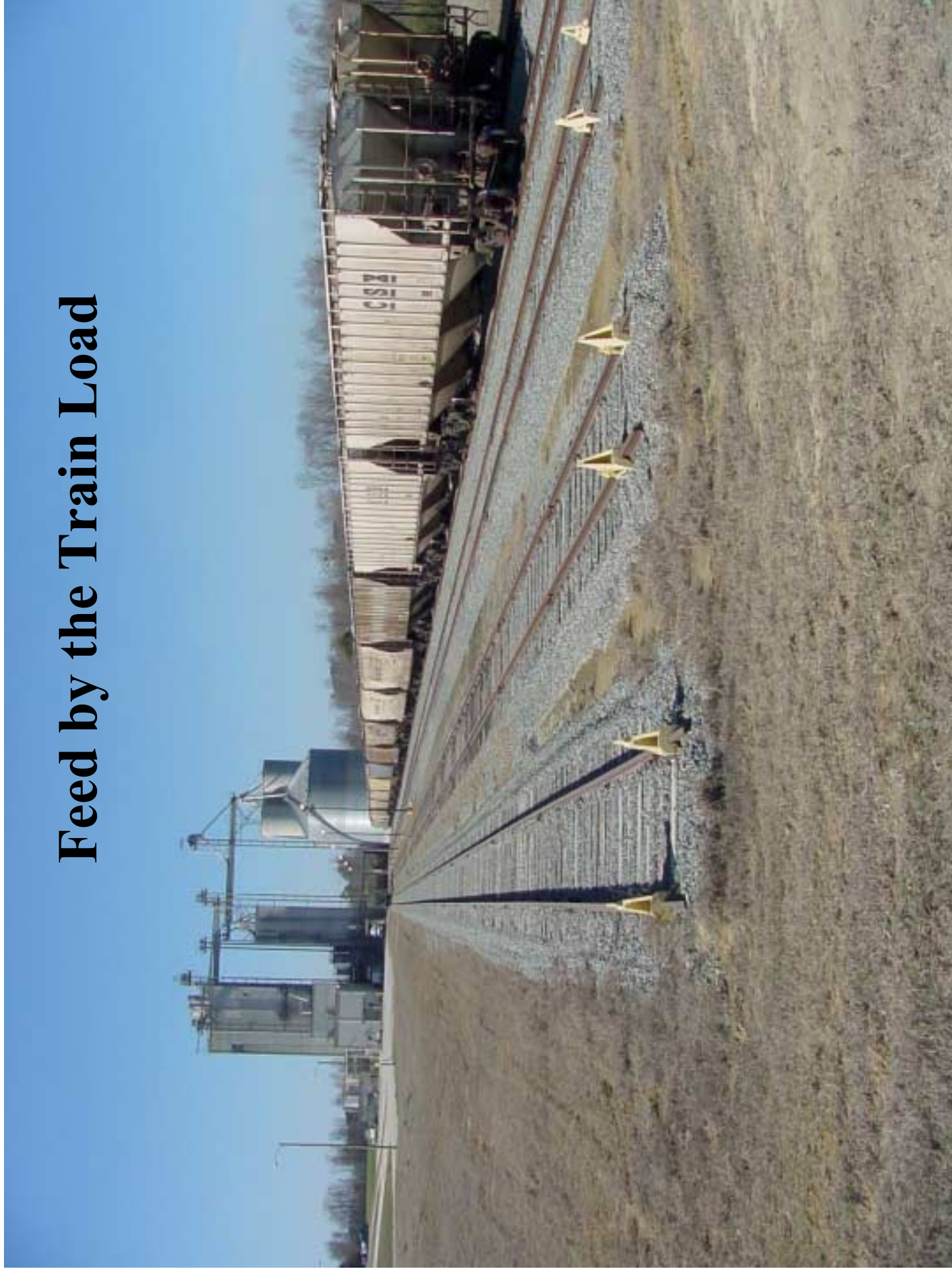
Swine Farms in Eastern North Carolina River Basins



Ecosystem consequences of geographic concentration of CAFOs:

- **Local feed crop production can't support local animal production**
- **Feed imports (“new nutrients”) create nutrient loading imbalances**
- **Carcass (“protein”) production > local demand**
- **Manure production > local demand for fertilizer**

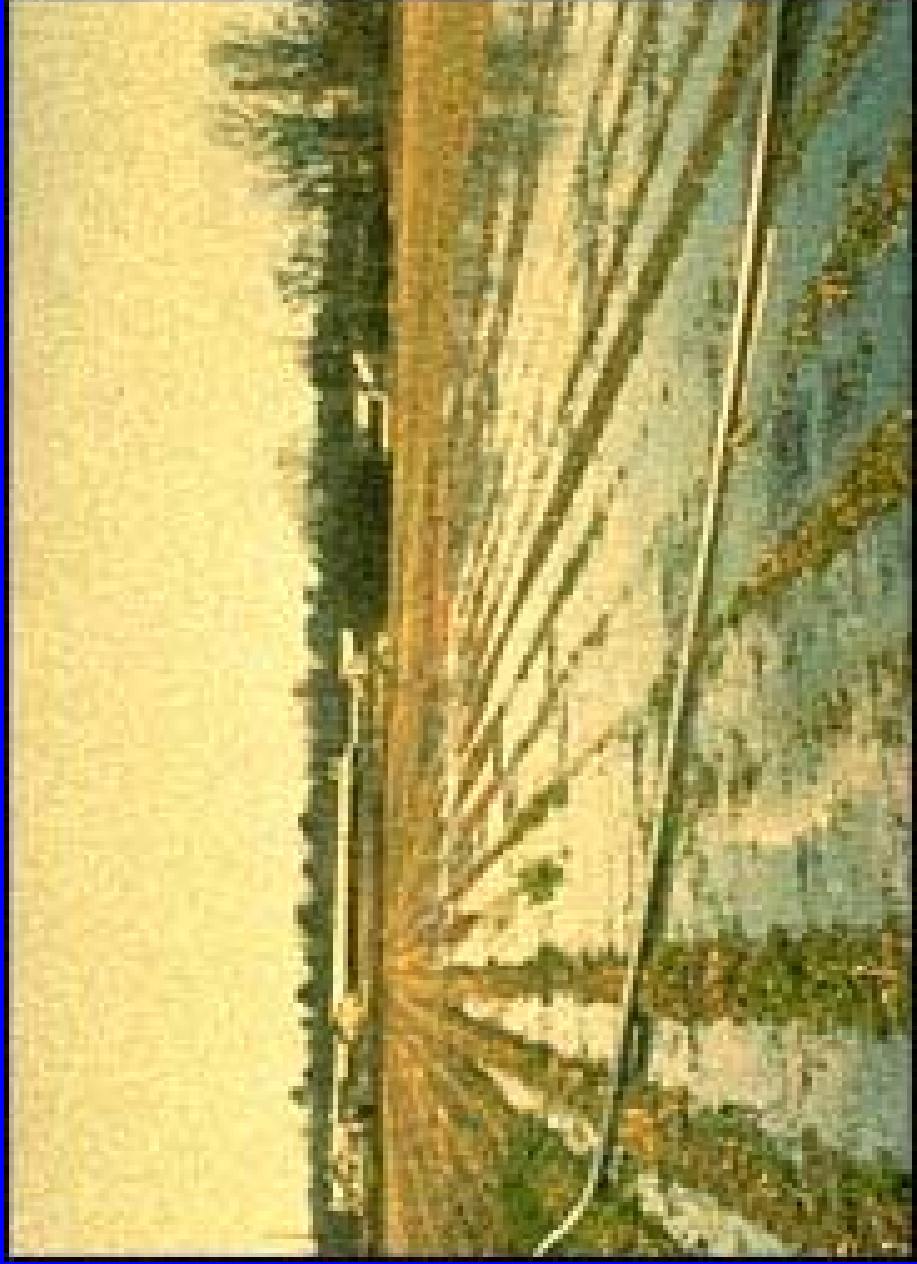
Feed by the Train Load



Environmental Economics

- **Supplies of waste > demand**
- **Value of waste as fertilizer declines, and much of the waste is no longer a resource**
- **Producers pay costs of waste disposal**
- **The result is economic incentives to find low cost waste disposal or simply to cheat**

Sometimes more waste is sprayed on fields than can be absorbed . . .



Rockfish Creek



Cities of animals: Antibiotic use

- Drugs, especially antibiotics, are used on a routine basis to compensate for crowded and often stressful conditions on industrial-scale farms.
- By one recent estimate, about 70% of all antibiotics used in the US are given to livestock and poultry that are not sick.
- Agricultural use of antibiotics is now recognized as a significant contributor to the human health threat from antibiotic resistant bacteria.

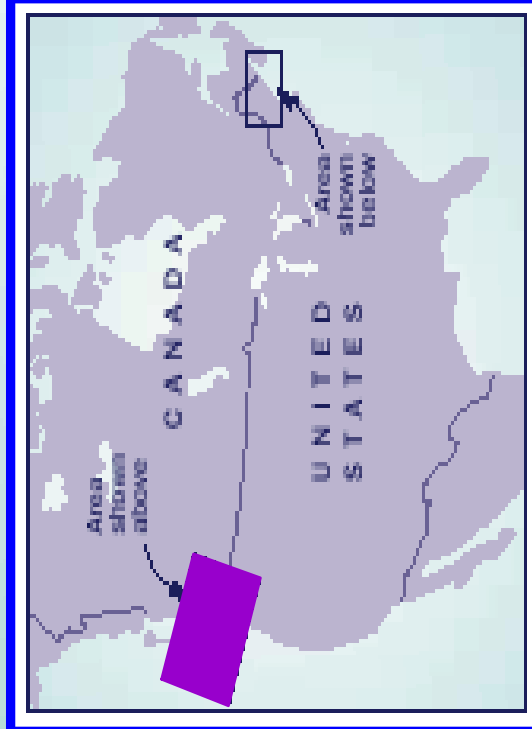
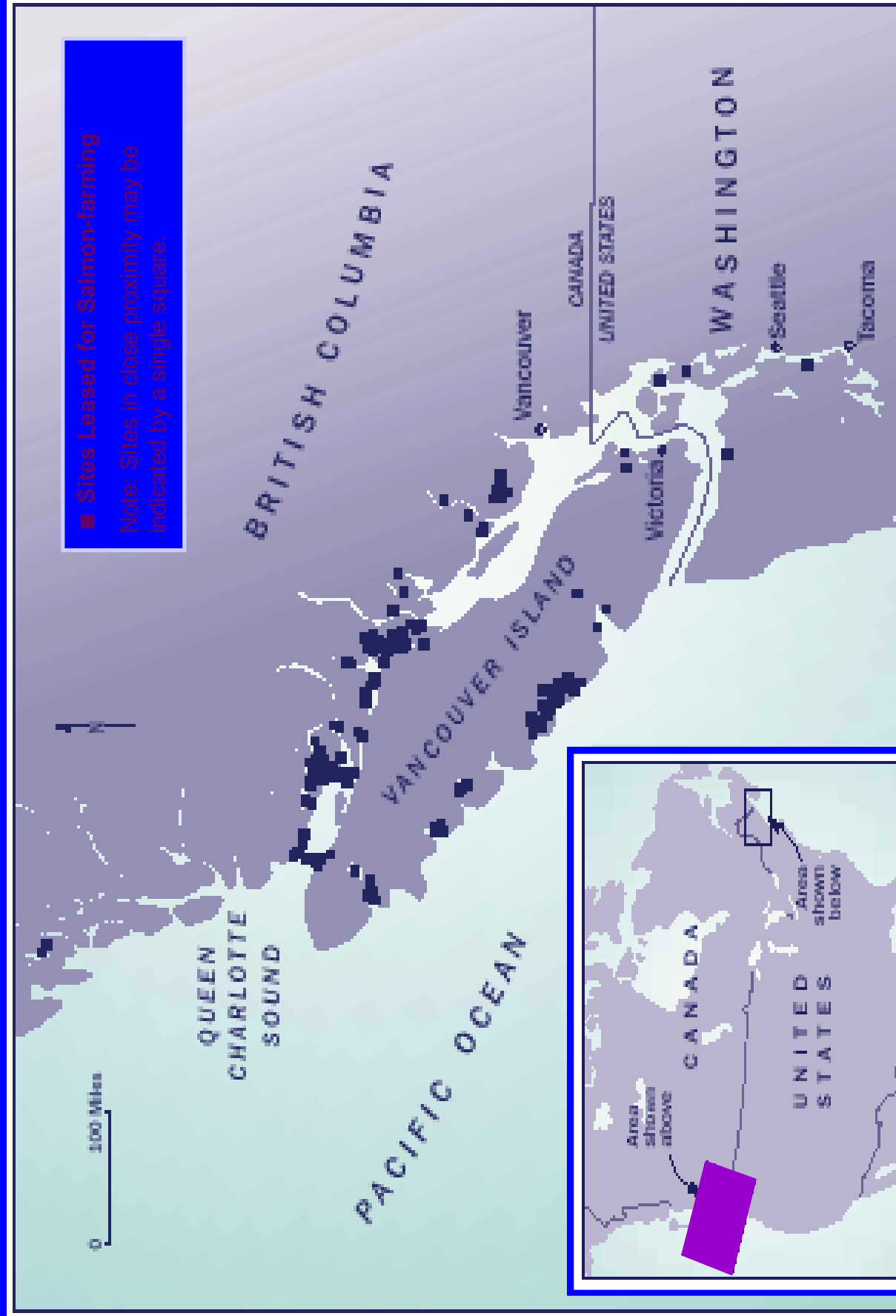
What does this have to do with marine
aquaculture?

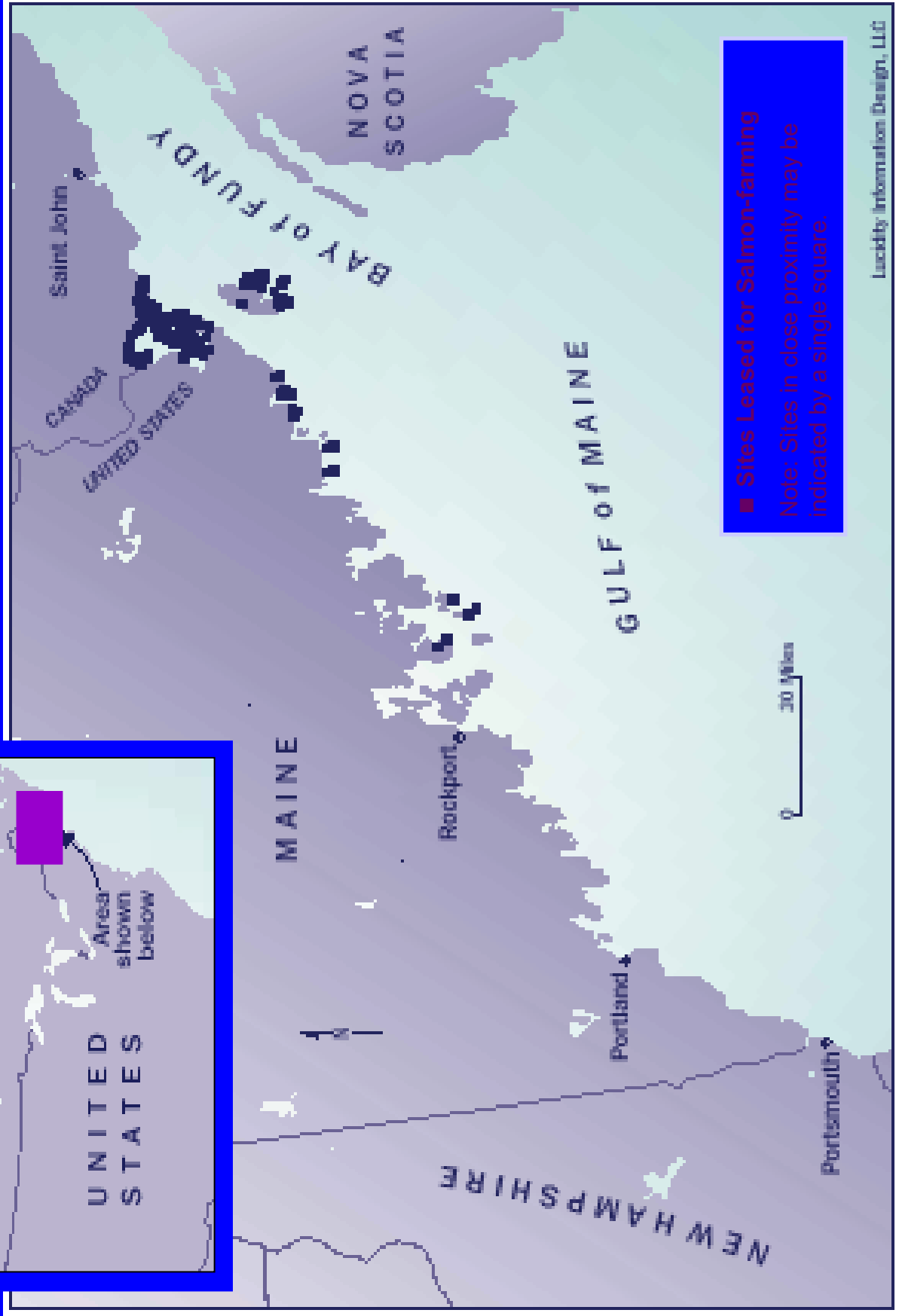


Cities of salmon



■ Sites Leased for Salmon-farming
Note: Sites in close proximity may be indicated by a single square.





Waste production by salmon farms is sizeable

- **Four salmon netpens in Washington State in 1997 discharged 0.93 the amount of total suspended solids into Puget Sound as the sewage treatment plant serving the city of Seattle at a cost of \$80 million/year.**

Similarities and differences in waste disposal

- Marine fish netpens discharge into coastal waters, not streams and rivers.
- Wastes on hog and poultry farms is supposed to be contained on farm –it is supposedly contained and not discharged into water bodies.
- Which has more impact?

Similarities and differences in waste disposal

- **Siting as a constraint?**
 - **Marine fish farms usually in public waters – must get permits/licenses**
 - **Hog and poultry farms on private land – although must get permits**

Similarities and differences in antibiotic use

- **Salmon and many other fish farms use far fewer antibiotics than terrestrial animal production**
- **“Food pathway” for antibiotic resistance is much more important for terrestrial animals than fish**
- **“Minor Use Minor Species” bill in Congress is intended to increase the availability of drugs, including antibiotics, in aquaculture**

The future – ocean farming of cod, halibut and other species?





Impact of moving beyond salmon farming?

- **Impact of any one facility may be small**
- **But, what would the cumulative impact be of a “successful” expansion of marine fish farming?**
- **Do we still believe the ocean is so vast and limitless that we do not have to worry about its degradation by humans?**

Public perception

- If marine aquaculture is perceived as a “dirty” industry, will it be able to expand in North America?
- Will it ultimately move to developing countries (e.g. South America which has a large supply of feed ingredients)?

Models for the future?



Integrated aquaculture?



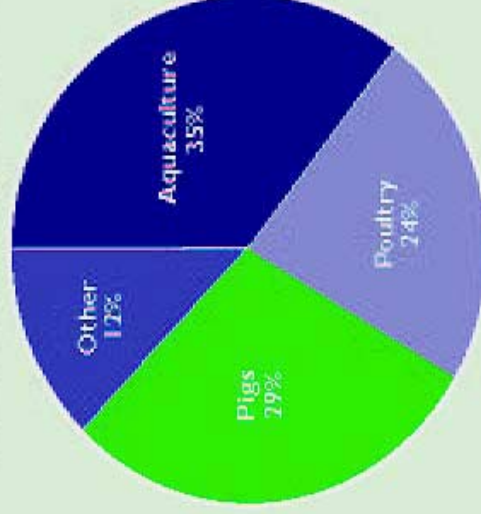
**Both terrestrial and marine animal production
uses capture fisheries for feeds inputs**



Share of total fishmeal use, 1988



Share of total fishmeal use, 2000



ESTIMATED 2001 FISH MEAL USE IN WORLD AQUACULTURE

FISH	PRODUCTION *	PRODUCTION USING COMPOUND FEEDS*	WILD FISH USED IN COMPOUND FEEDS*	RATIO OF WILD FISH TO FED FARMED FISH
Marine Finfish	974	604	2,378	3.94
Eel	231	187	842	4.50
Salmon	1,200	1,200	2,779	2.32
Marine Shrimp	1,271	1,055	2,374	2.25
Trout	567	567	829	1.46
Tilapia	1,385	582	327	0.56
Milkfish	495	208	175	0.84
Catfish	434	373	112	0.30
Fed Carp	10,549	4,009	1,879	0.47
Filter-feeding Cp.	5,879	0	0	0
Mollusks	11,270	0	0	0

*thousand metric tons

Net fish production from aquaculture (based on fishmeal use only)

	<u>1997</u>	<u>1998</u>	<u>2001</u>
Ratio wild fish to fed farmed fish	1.90	1.60	1.36
Wild fish used in fish feeds	10 Mt	10 Mt	12 Mt
Total aquaculture production*	29 Mt	31 Mt	37 Mt

***Includes farmed fish that are not given compound feeds**

Challenges from aquaculture's dependence on wild fisheries

- **Finite stocks of small pelagic fish used for fishmeal available as aquaculture grows.**
- **Demand for small pelagic fish for direct consumption will grow with human population and affluence, as well as rising prices for other fish.**
- **Stocks of small pelagic fish critical food for marine predators, including commercially valuable fish.**

Food safety

- Three small studies now indicate that farmed salmon may have much higher levels of PCB's than wild salmon – high enough that under EPA guidelines consumers should only eat one meal per month



Conclusions

- Aquaculture development **should not simply copy** intensive “industrial” systems for animal production, but also consider alternative paths
- Consideration of the potential **cumulative impact** of aquaculture development is critical
- Reducing aquaculture’s **dependence on capture fisheries** for feed will likely have multiple benefits