One Step at a Time: Incremental implementation of a water quality permit program

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Land Use and Discharge Permit Programs

- A discharge permit progam which includes nonpoint sources is dependent upon a definition of land use and the property rights associated with that land use.
- Allowing discharge permits to be tradable increases the potential for cost efficient achievement of environmental targets

Water Quality Trading

- *"Trading is a way to address the entire needs of a watershed – not just isolated point source discharges…**a cost-effective method** to solve water quality challenges."* Stephen L. Johnson, Administrator of the U.S. Environmental Protection Agency, at the Second National Water Quality Trading Conference, Pittsburgh, PA on May 24th, 2006.
- *"…not all trading programs are equal. Some designs are better than others. Furthermore, one size does not fit all. Emissions trading programs can and should be tailored to each specific application."* *Tietenberg (2006), Emissions Trading: Principles and Practices, p. 207.*

What is nutrient trading?

- A market based approach for protecting and improving water quality that can enhance options available to reduce pollutant loadings.
- A way to achieve water quality goals cost effectively. Takes advantage of the fact that some pollution sources are easier (and less expensive) to reduce than others.
- Generates market demand for new, innovative technologies.

What trading is not

- Not a substitute for regulation; it is a policy tool that can be used alongside regulation.
- Not a way of letting the market decide the environmental outcome.
- Does not let polluters off the hook. It does allow sources facing high pollution reduction costs to purchase less costly reductions from other sources; but the reductions must be made and paid for.
- Does not exclude other policy approaches. Trading can be used in conjunction with other policy tools such as targeted subsidies, mandatory Best Management Practices, or public education campaigns.

Cap and Trade Programs

- Cap
  - A limit is set for the total amount of nutrients in a watershed
  - Permits are allocated among sources
- Trade
  - Institutional framework designed for allowing trades
  - Abatement measures are invested in by those sources that have the lowest-cost opportunities to reduce pollution

Cap and trade programs have not worked

- Few or no trades
  - Most trades have been PS/PS
  - Mostly pilots, many have faded
- Why have they not worked?
  - allocation problems (quantifying property rights, NPS)
  - low liquidity (inadequate supply and demand)
  - high transaction costs (high information costs, coordination of bilateral trades)
  - low incentives for investment in abatement for non-regulated sources (weak price signals)

Composite Market Model: Offset trading program

- Differs from a Cap and Trade scheme in how a cap is determined and how permits are allocated, trading principle is the same
- Individual pollution generating activities can be regulated and then abated or offset based on expected (modelled) discharges
  - since discharges cannot be controlled directly, the control mechanism is with the activities which generate pollution

Property rights and tradable permits

- Trading programs are based on establishing property rights
  - there needs to be a right before ownership can be transferred (traded)
  - Allocation assigns property rights
- What are these rights?
  - Tietenberg(2007): ...it prioritizes the right to access the resource to a specified degree"
  - Collentine (2006): ...do not represent a full set of property rights"

Property rights in a composite market program

- Determined for each pollution generating activity
- Two possibilities:
  - i) the right is held by the owner of the activity
  - ii) the right is held by the community/society
  - In the first case, the community must compensate the holder for infringements.
  - In the second case, the would-be user of the right must compensate the community for infringements.

Property rights in a composite market program

- How are rights determined? By regulation!
- In a composite market program rights are determined as a baseline of acceptable practices for each polluting related activity.
- Examples

Example 1: Catch crops

- Alternative 1a: If all producers of crops sown in the spring in Nitrate Vulnerable Zones (NVZ) are expected to sow a catch crop at the same time, then a producer who wished to not sow a catch crop would need to compensate the community for the infringement by paying the social (opportunity) cost for the expected excess discharge. In the composite market program this is calculated as the marginal cost of a comparable reduction from another source, the price of a permit.

Example 1: Catch crops

- Alternative 1b: If sowing catch crops were an elective measure (not required) then society would need to compensate the producer for the infringement by paying the opportunity cost to induce them to choose to sow a catch crop. In a composite market program this generates a discharge credit which could be sold.

Environmental effects

- In both of these alternatives the effect of the measure (catch crops) must be calculated, (estimated). In the first case, so that the producer will know the number of permits which must be acquired and in the second case so that the value of the credit can be assessed, the value of the abatement.
- This quantifies the property right.
  - Normalized to the estimated effects on nutrient losses of the activity at the recipient .

Example 2: Fertilization rates

- Alternative 2a: If an acceptable fertilization practice ("good agricultural practice") for spring-sown grains was determined to be 100 kg N/ha for land within NVZs then in a composite market scheme a producer who wished to exceed this rate must purchase compensating permits for the estimated excess N losses associated with the higher rate.

Example 2: Fertilization rates

- Alternative 2b: Under the same baseline condition a producer who used less then 100 kg N/ha would have an opportunity to sell the reduced N loss associated with the lower rate. However, this does not mean that a buyer would be found (a credit created).

Composite Market System

- Three integrated markets:
  - a) Primary contract market
  - b) Primary permit market
  - c) Secondary permit market
- Different functions for each market
  - a) Setting permit prices
  - b) Issuing (selling) permits
  - c) Market exchange

Implementation of the Composite Model

- Creating supply
  - Setting permit prices at the marginal cost of abatement
  - Establishing baselines
- Creating demand
  - Regulating activities
  - Establishing baselines
- Setting up a trading framework (institution)
  - Trading rules

Case study: Rönne River

- Setting prices for N permits
- Creating demand for N permits
- Numerical analysis
  - BMPs: Catch crops and spring tillage
  - Regulation: Household septic system

Setting Prices for N permits

Three steps

1) BMPs: Catch crops, spring cultivation and combination (subsidies)
2) Runoff model: SOILNDB (TRK project), modelled discharge by soil type and subcatchment
3) Estimated MCA: Setting permit prices

Figure 1. Rönne River basin

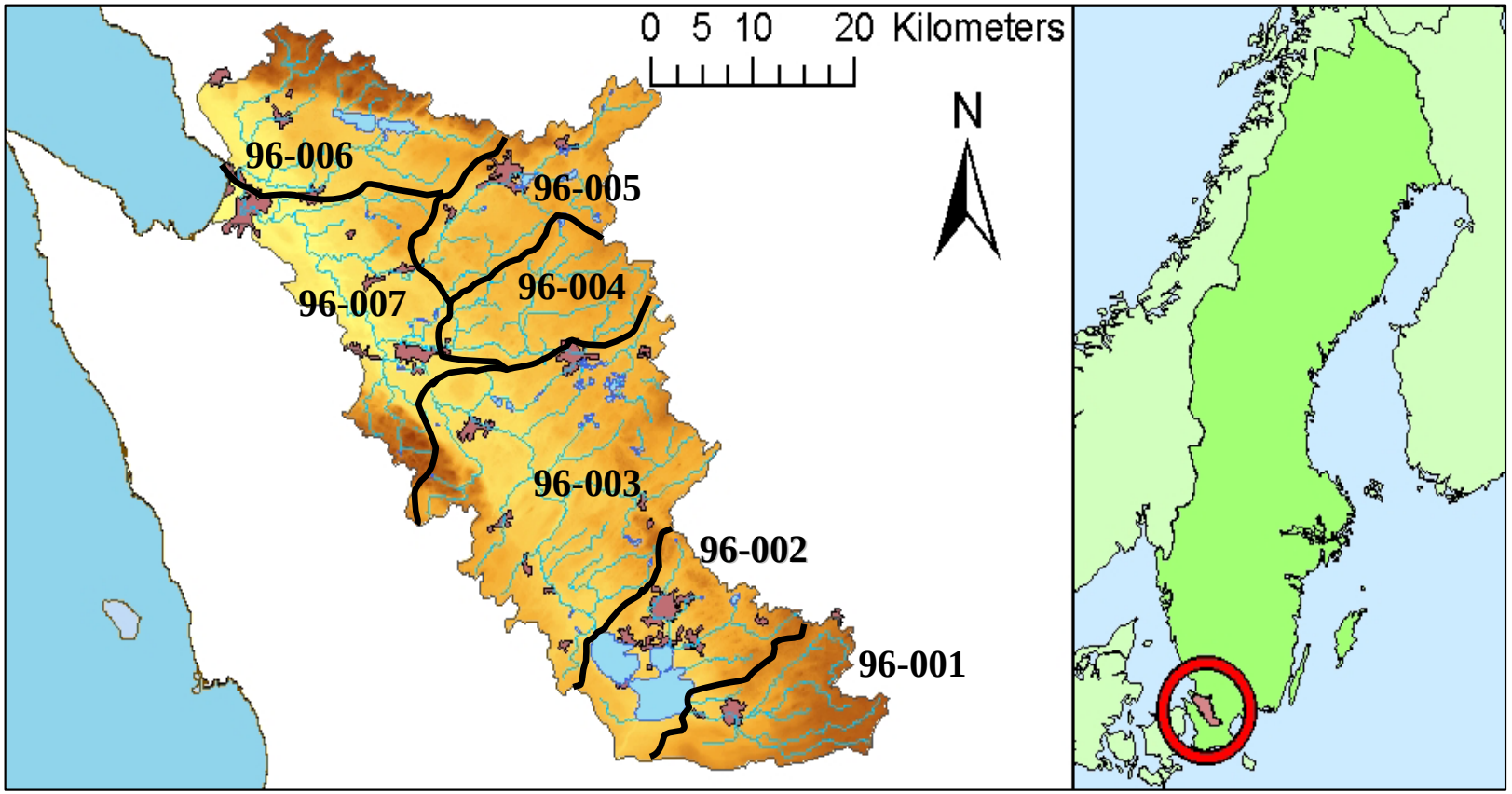


Table 1. Estimated leaching by soil type and BMP (kg/ha) and subsidy.

	Loam	Loamy sand	Sandy loam	Subsidy USD/ha
No measures applied	53	70	62	
Catch crop and spring tillage (reduction)	29 (24)	36 (34)	33 (29)	$162.50
Catch crop only (reduction)	38 (15)	51 (19)	44 (18)	112.50
Spring tillage only (reduction)	45 (8)	58 (12)	52 (10)	50.00

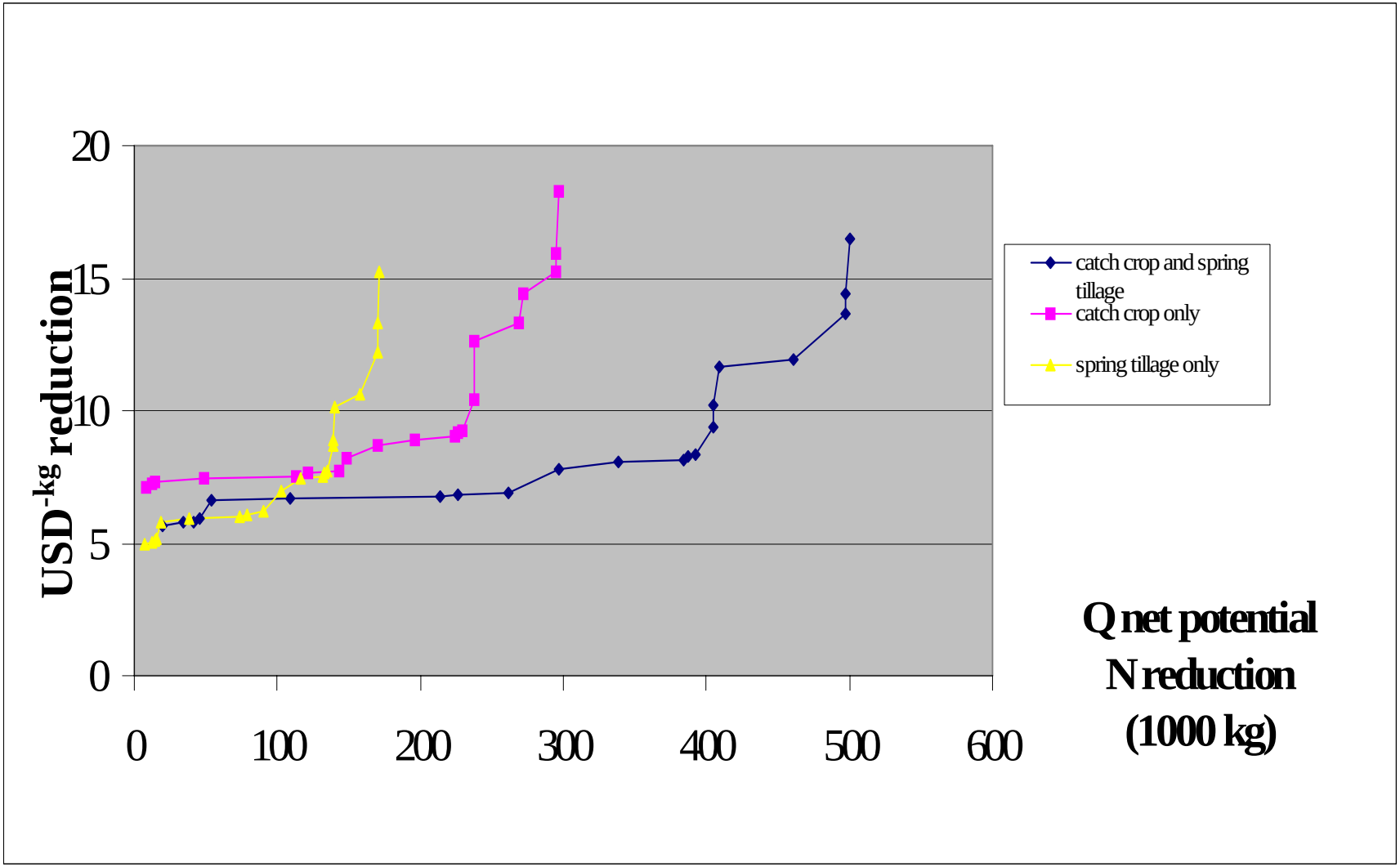
Table 2a: Cost per kg per unit of net leaching reduction (USD/kg)

	subcat 96-001	subcat 96-002	subcat 96-003	subcat 96-004	subcat 96-005	subcat 96-006	subcat 96-007
Catch crop and spring tillage							
loam	$14.40	$16.51	$8.16	$8.36	$8.26	$9.40	$8.06
loamy sand	10.18	11.66	5.76	5.90	5.83	6.64	5.69
sandy loam	11.93	13.66	6.75	6.91	6.84	7.79	6.68
Catch crop only							
loam	15.96	18.29	9.04	9.26	9.15	10.41	8.93
loamy sand	12.60	14.44	7.14	7.31	7.23	8.23	7.05
sandy loam	13.30	15.25	7.53	7.71	7.63	8.68	7.44
Spring tillage only							
loam	13.30	15.25	7.53	7.71	7.63	8.68	7.44
loamy sand	8.86	10.16	5.03	5.15	5.09	5.79	4.96
sandy loam	10.64	12.20	6.03	6.18	6.10	6.95	5.95

Table 2b: Total potential reduction (in tons).

	subcat 96-001	subcat 96-002	subcat 96-003	subcat 96-004	subcat 96-005	subcat 96-006	subcat 96-007
Catch crop and spring tillage							
loam	0	3.4	45.6	5.9	2.6	11.7	41.4
loamy sand	0	4.8	14.4	4.2	7.4	8.3	19.6
sandy loam	51.3	36.6	104.1	35.4	12.6	35.5	55.6
Catch crop only							
loam	0	2.1	28.5	3.7	1.6	7.3	25.9
loamy sand	0	2.7	80.2	2.3	4.1	4.7	10.9
sandy loam	31.8	22.7	64.6	22.0	7.8	22.0	34.5
Spring tillage only							
loam	0	1.1	15.2	2.0	0.9	3.9	13.8
loamy sand	0	1.7	5.1	1.5	2.6	2.9	6.9
sandy loam	17.7	12.6	35.9	12.2	4.3	12.2	19.2

Figure 2. Supply curve for selected BMPs



Creating demand for N

- Regulating activities, establishing ”baselines”
- Household septic systems, function related standard:
  - 50 % N removal
  - 90% P removal
- 40% of properties with septic systems are not in compliance with current standards

Estimated gross N loads from septic systems in the Rönneå catchment that do not comply with standards

Kommun and group (A,B)	Number of septic systems[]	Type of system Sludge seperation Number (gross load)2]	Type of system Infiltration pit Number (gross load)3]
Ängelholm (A)	2914	670 (4080 kg/yr)	612 (4284 kg/yr)
Örkelljunga (A)	1992	124 (755 kg/yr)	42 (294 kg/yr)
Klippan (A)	1732	183 (1114 kg/yr)	74 (518 kg/yr)
Perstorp (A)	722	722 (1145 kg/yr)	31 (217 kg/yr)
Group A gross load		**7094 kg/yr**	**5313 kg/yr**
Hörby (B)	3170	792 (4823 kg/yr)	136 (952 kg/yr)
Höör (B)	2503	651 (3965 kg/yr)	108 (756 kg/yr)
Group B gross load		**8788 kg/yr**	**1708 kg/yr**
Total gross load		**15881 kg/åyr**	**7021 kg/yr**

[1] PLC5 (SCB)
[2] Estimated loading 7 kg/yr and removal rate(13%), PLC5.
[3] Estimated loading 7 kg/yr and removal rate (0%), PLC5.

Estimated net N loads from septic systems in the Rönneå catchment that do not comply with current standards

Group	Gross load N kg/year	Transport Coefficient	Net load N kg/year
Group A	7094 + 5313	80%	9925
Group B	8788 + 1708	45%	4723
Total			**14648***

***Arheimer et al (2006) estimated this at 17.78 t/yr**

Permit pricing?

- What would it cost to reduce N load to the sea by 14.6 tonnes from another source (agriculture?)
- Answer can be found in Tables 2a and 2b (and in the supply curve for abatement measures)

Table 2a: Cost per kg per unit of net leaching reduction (USD/kg)

	subcat 96-001	subcat 96-002	subcat 96-003	subcat 96-004	subcat 96-005	subcat 96-006	subcat 96-007
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Table 2b: Total potential reduction (in tons).

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sandy loam	17.7	12.6	35.9	12.2	4.3	12.2	19.2

Permit pricing

- The marginal cost for reducing 14.6 tonnes of N to the sea is $5.09 or 40 SEK/kg (spring tillage on sandy loam in subcatchments 96-003,-005,-007).
- Number of permits which every property owner that does not want to upgrade their septic system to comply with standards must have depends on the type of septic system and subcatchment location.

Estimated N load to the sea by type of septic systems and subcatchment location, annual cost valued at 40 SEK/kg

Type of system	Subcatchment A Load kg/year	Cost	Subcatchment B Load kg/year	Cost
Infiltration pit	5,6	224 SEK/yr	3,15	126 SEK/yr
Sludge seperation	4,87	195 SEK/yr	2,74	109 SEK/yr

Comments

- Permit quantities need to be normalized (one kg N to the sea), number of required permits can be rounded to the nearest kg
- Administration costs are not included
- Permits need to be time specified
- Number of permits refers only to N loads, in the case of septic systems there would also need to be a permit for P loads as well
- Permit trading? (repurchase?)

Incremental implementation of a water quality permit program

- One step at a time (partial information)
- Establishing baselines
  - Individual emission activities
- Creating demand for permits
  - Regulating land use for individual activities
- Setting permit prices
  - Based on the marginal cost of abatement (dynamic)
- Establishing a trading institution

Next steps

- Expanding the information in the abatement supply curve
  - Phosphorus loss BMPs and modelling!
  - Other BMP measures (wetlands, buffer strips)
  - Other sources of potential abatement (oysters)
  - Reverse auctions for BMPs
- Institutional design
  - Scale? Subcatchment, Catchment, Basin
  - Recipient? (N? P? the same?)
  - Administration? Political boundaries (WFD)?
  - Costs?
- Legal framework? (regulation, earmarked taxes)

References

- Collentine, D. (working paper). One Step at a Time: Incremental implementation of a water quality permit program. Available at http://www.hig.se/~nisrum/SubmissionTrading.pdf
- Collentine, D. (2006). Composite Market Design for a Transferable Discharge Permit (TDP) System. *Journal of Environmental Management and Planning*, 49(6), 929-946.
- Collentine, D. (2005a). Phase-in of nonpoint sources in a Transferable Discharge Permit (TDP) system for water quality management: setting permit prices. *Ambio*, 34, 573-578.
- Collentine, D. (2005b). Including non-point sources in a water quality trading permit program, *Water Science and Technology*, 51, 3-4.


Thank you for your attention!
Questions? Comments?