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Valuing New Hampshire Salt Marshes: An Approach to Measuring Ecosystem Services

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Valuing Restoration of New Hampshire Salt Marshes: An Approach to Measuring Ecosystem Services

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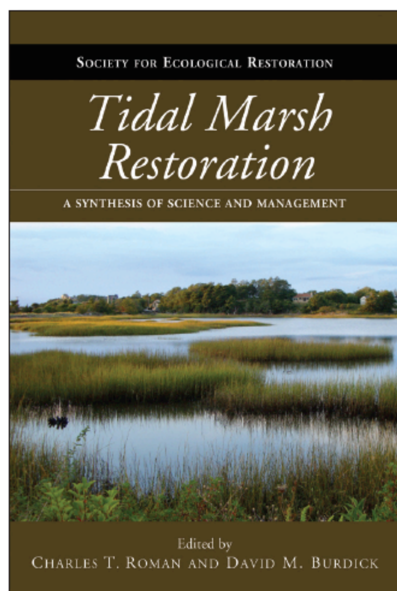
Tidal Restrictions continue to degrade protected marshes



7 X 10. 432 pages. 2012.
53 figures, 24 tables, references, index.
978-1-59726-576-8
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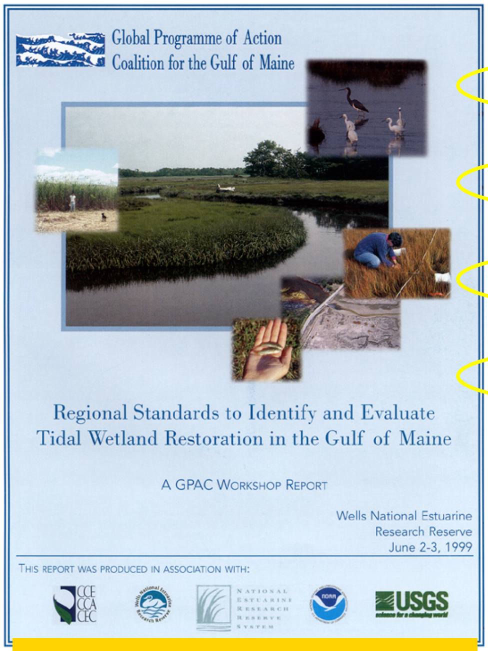
Restoration can be costly – is it worth it?

Evaluating Restoration

- "Success", Pass/Fail?
- Defined by Acres, Structure, Function?
- No Unified Method, No Unified Parameters
- Can sites be compared? *readily*, *meaningfully*?

Gulf of Maine "GPAC" Protocols



- Hydrology

Tidal Signal (WL Recorders), Elevation

- Soils and Sediments

Salinity (and Sulfide, Eh, %C, accretion)

- Vegetation

Abundance, Composition, Invasive spp, Ht.

- Nekton

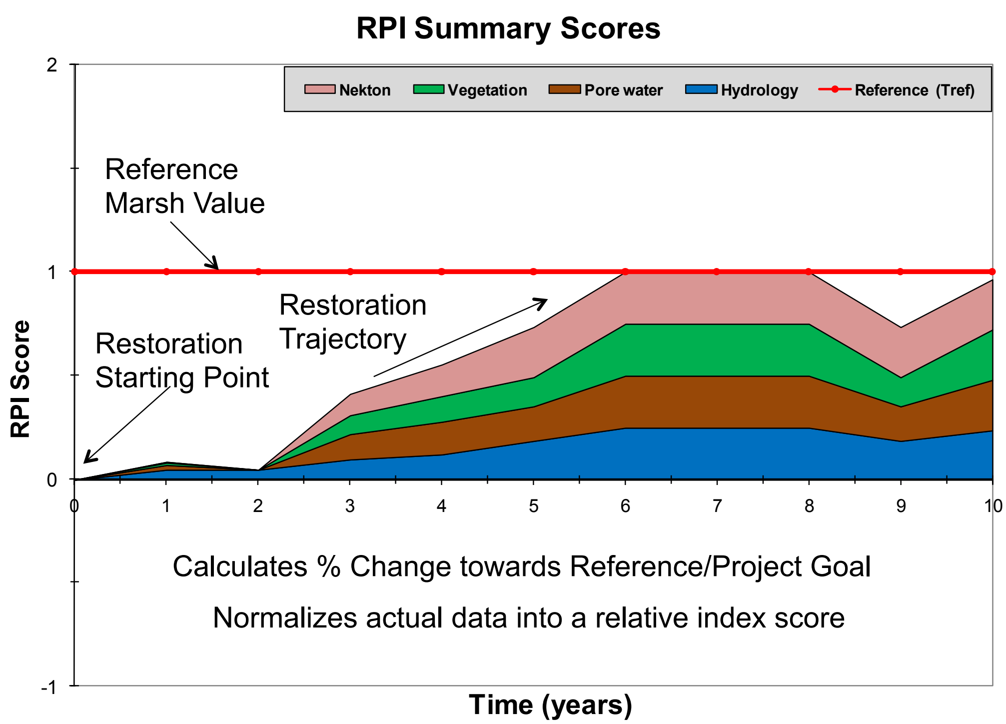
ID, Density, Length, Biomass, Richness

- Birds

Abundance, Richness, Behavior

Neckles et al. 2002. Restoration Ecology. 10(3):556-563. → Konisky et al. 2004.

RPI – An Evaluation Tool



Calculates % Change towards Reference/Project Goal

Normalizes actual data into a relative index score

RESTORATION PERFORMANCE INDEX

$$RPI = \frac{\text{Restoration change}}{\text{Initial difference from reference}}$$

$$\frac{(\text{Salinity}_{present} - \text{Salinity}_{pre\text{-}restoration})}{(\text{Salinity}_{reference} - \text{Salinity}_{pre\text{-}restoration})}$$

$$\frac{(20ppt - 10ppt)}{(30ppt - 10ppt)} = 0.5$$

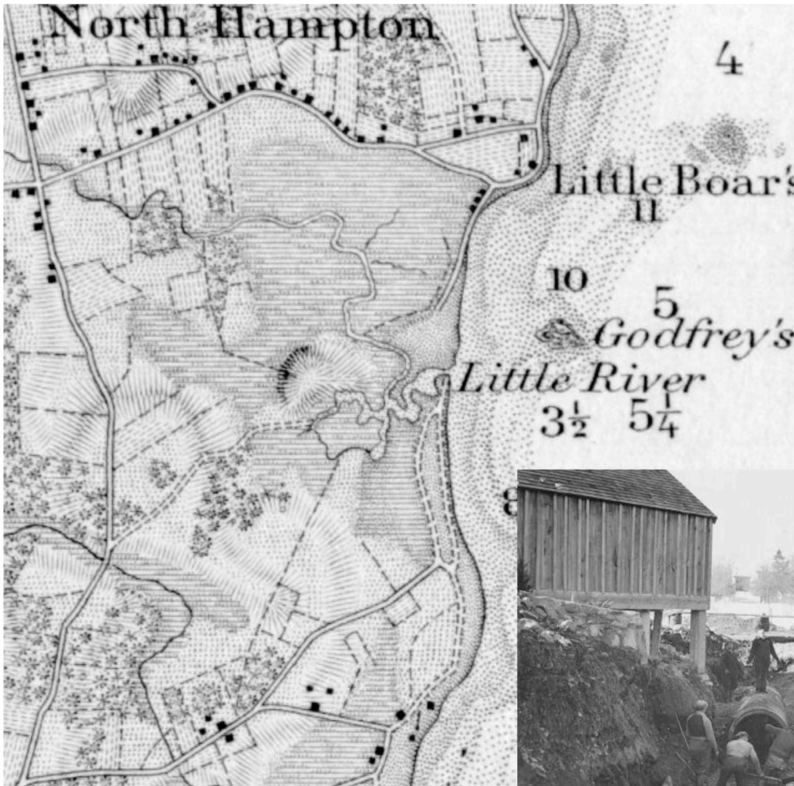
Example Marsh Scenario

4 Functional Areas → Each = 1/4 Contribution

Hydrology	Vegetation	Pore water	Nekton
-Tidal Range	-Native % Cover	-Salinity (psu)	-Abundance
-Flooded Area	-Biomass	-Redox (mV)	-Diversity
		-Sulfide (mM)	

Calculates % Change towards Reference/Project Goal

Normalizes actual data into a relative index score



Case Study:
Little River
Marsh, NH

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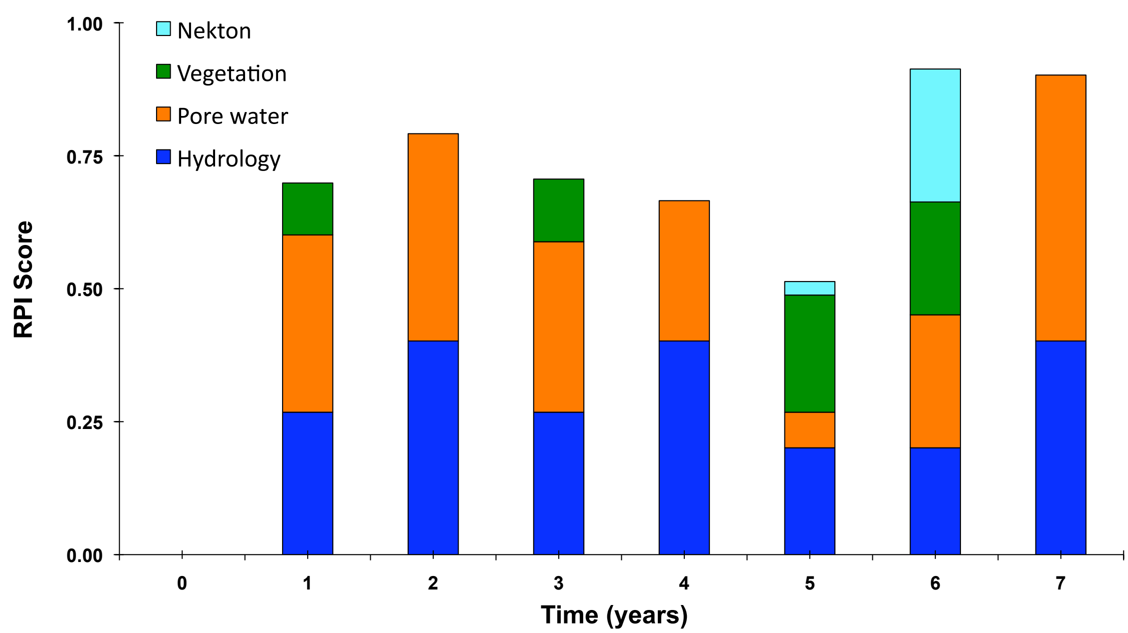
Little River
Marsh, NH

RPI Calculations for Little River Marsh

Functional Area	Core Variable	Year 0 (Pre) Ref.	Year 0 (Pre) Pre-Rest.	Year 1 (Post) Ref.	Year 1 (Post) Rest.	*Partial RPI*	Year 2 Ref.	Year 2 Rest.	Year 3 Ref.	Year 3 Rest.
Hydrology	Area Flooded (%) Spring Tide	98.2	45.5	98.2	99.1	*1.00*	98.2	99.1	98.2	99.1
	Area Flooded (%) Neap Tide	18.6	0.0	18.6	74.3	*1.00*	18.6	74.3	18.6	74.3
	Potential Range (m) Spring Tide	1.77	0.57	1.83	1.36	*0.63*	1.83	1.36	1.83	1.36
	Potential Range (m) Neap Tide	1.26	0.23	1.17	0.77	*0.58*	1.17	0.77	1.17	0.77
Pore water	Salinity (ppt)	26.2	17.5	25.0	25.7	*1.00*	29.2	26.6	31.5	31.0
Vegetation	Halophyte Cover (%)	65.9	59.9	70.9	39.9	*0.00*			64.6	34.5
	Invasive Cover (%)	0.0	10.2	0.0	2.7	*0.59*			0.1	2.1
Nekton	Density (#/m2)	20.1	12.7							
	Species Richness	7.5	3.1							
RPI			**0.59**		**0.70**			**0.79**		**0.71**

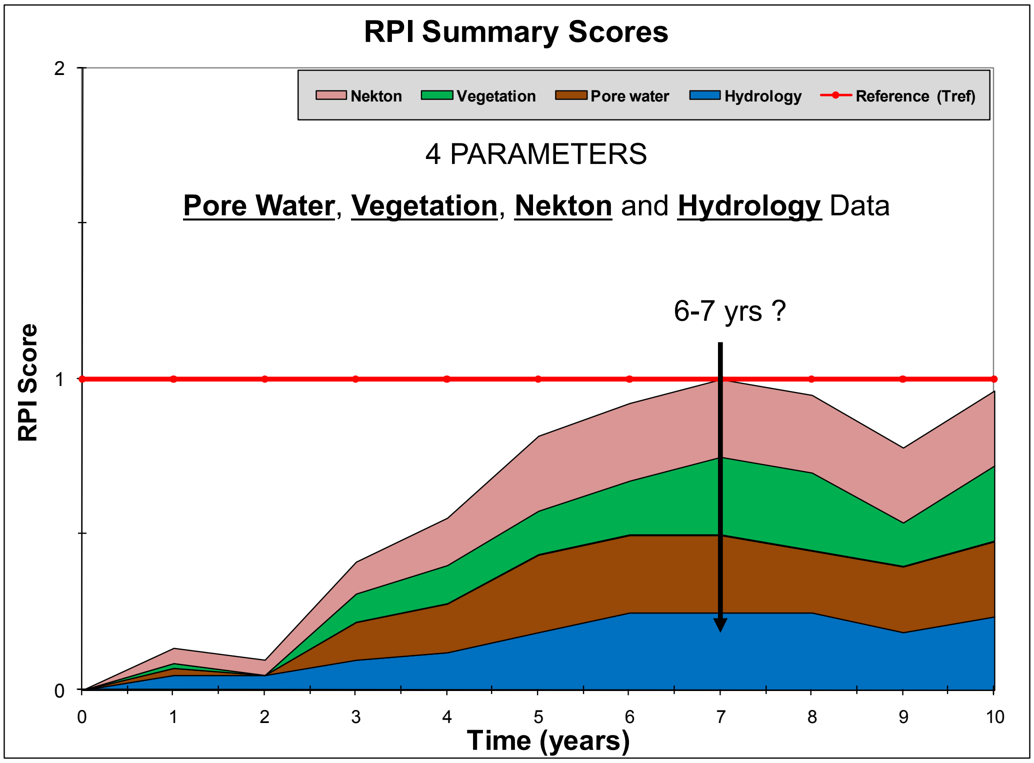
Functional Area	Core Variable	Year 4 Ref.	Year 4 Rest.	Year 5 Ref.	Year 5 Rest.	Year 6 Ref.	Year 6 Rest.	Year 7 Ref.	Year 7 Rest.
Hydrology	Area Flooded (%) Spring Tide	98.2	99.1	98.2	99.1	98.2	99.1	98.2	99.1
	Area Flooded (%) Neap Tide	18.6	74.3	18.6	74.3	18.6	74.3	18.6	74.3
	Potential Range (m) Spring Tide	1.83	1.36	1.83	1.36	1.83	1.36	1.83	1.36
	Potential Range (m) Neap Tide	1.17	0.77	1.17	0.77	1.17	0.77	1.17	0.77
Pore water	Salinity (ppt)	31.5	24.9	25.4	19.6	22.7	23.6	28.6	29.4
Vegetation	Halophyte Cover (%)			68.0	51.8	63.4	63.6		
	Invasive Cover (%)			0.0	1.9	0.0	3.1		
Nekton	Density (#/m2)			35.6	13.8	35.6	38.0		
	Species Richness			9.0	4.0	6.00	9.0		
RPI			**0.67**		**0.51**		**0.91**		**0.91**

RPI Scores for Little River Marsh



NOAA funded study 2009: Moore, Burdick, Peter, Leonard-Duarte and Dionne

REGIONAL ASSESSMENT OF TIDAL MARSH RESTORATION IN NEW ENGLAND USING THE RESTORATION PERFORMANCE INDEX



NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

Measuring Salt Marsh Plant, Soil, and Hydrologic Response to Restoration Using Performance Benchmarks from Local Reference Systems at NERRs

M. Dionne, C. Peter*, K. Raposa, S. Lerberg, J. Fear, C. Cornu, N. Garfield

RESERVE	HYDROLOGIC	EXCAVATION
Wells, ME (1 reference site)	4	
Narragansett, RI (3 reference sites)	5	
Chesapeake Bay, VA (2 reference sites)		3
North Carolina (1 reference site)		3
South Slough, OR (2 reference sites)	2	1
Total Restoration Sites	11	7

Valuing benefits from salt marsh restoration

Assessment:
Structural indices (hydrology, soils, vegetation, nekton)

Goals:
To restore natural functions
To provide benefits or values to people

-a disconnect

Functional values associated with tidal marshes:

- Plant growth to support food webs
- Secondary production - fisheries
- Plant structure to provide habitat
- Support of biodiversity
- Protection from flooding
- Protection from coastal erosion
- Removal of sediments and excess nutrients
- Aesthetic, Recreational & Educational values
- Self-sustaining ecosystems
- Long term carbon storage

Ecosystem Services

Daily et al. 1997 No Particular Ecosystem	Costanza et al. 1997 Tidal marsh & mangroves	Millennium Assmnt. 2005 Estuaries & marshes	Zedler & Kircher 2005 Wetlands	Brander et al. 2006 Wetlands
not included	food production; raw materials	fiber, timber, fuel	food production; raw materials	commercial and recreational fishing & hunting; harvesting of natural materials; energy resources
maintenance of biodiversity	habitat/refugia	biodiversity	habitat/refugia	appreciation of species existence
provision of aesthetic beauty and intellectual stimulation that lift the human spirit	recreation	cultural & amenity; aesthetics; recreational	cultural; recreation	recreational activities; appreciation of uniqueness to culture/heritage
protection of coastal shores from erosion by waves.	disturbance regulation	flood/storm protection; erosion control	disturbance regulation	storm protection flood protection
protection - UV rays; climate stabilization; moderation of weather extremes & impacts.	not included	atmosphere & climate regulation	gas regulation	climate stabilization; reduced global warming
purification of air & water; detoxification & decomposition of wastes	waste treatment	waste processing	waste treatment	improved water quality; waste disposal
cycling & movement of nutrients	none	nutrient cycling & fertility	nutrient cycling	improved water quality; waste disposal

Value of Tidal Marsh Ecosystem Services per Annum per Hectare

- Costanza et al. 1987: $9,900
- In 2008 $ (Gedan et al. 2009): $14,400
- Carbon sequestration (European market): $135
- Denitrification (Piehler and Smyth 2011): $6,128

R.T. Woodward, Y.-S. Wui / Ecological Economics 37 (2001) 257–270

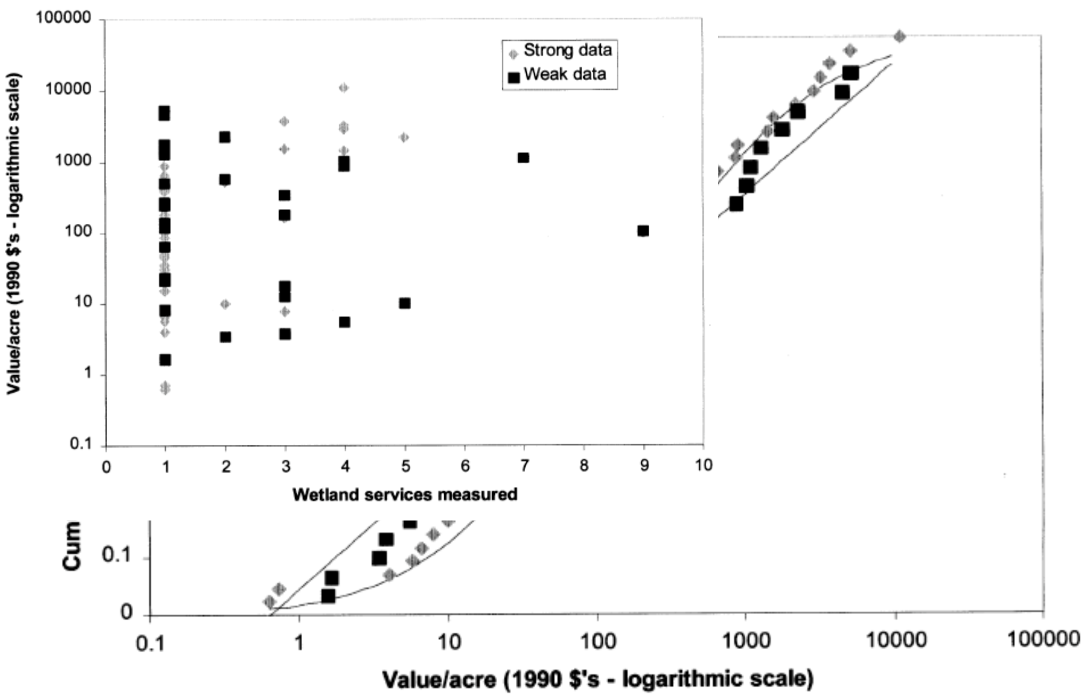


Fig. 1. Cumulative distributions of wetland values broken down by study quality.

Value of Tidal Marsh Ecosystem Services per Annum per Hectare

- Will researchers develop better estimates for specific functional values over time?
- Will some values overlap and perhaps conflict?

PROBABLY!

But . . .Let's take the next step anyway

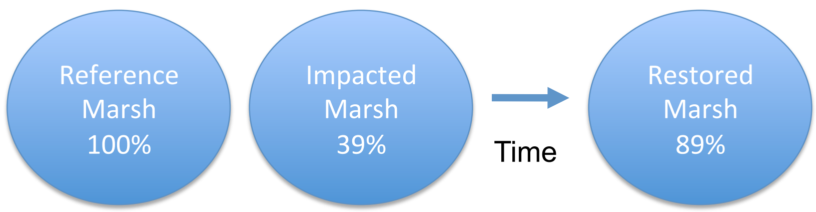
New Valuation Strategy

Take:

Ecological Valuation - structural and functional indicators used to measure marsh response to restoration

Set it equal to:

Economic Valuation – ecosystem service values of Costanza et al. 1997 (2008: $14,400/ha/yr)

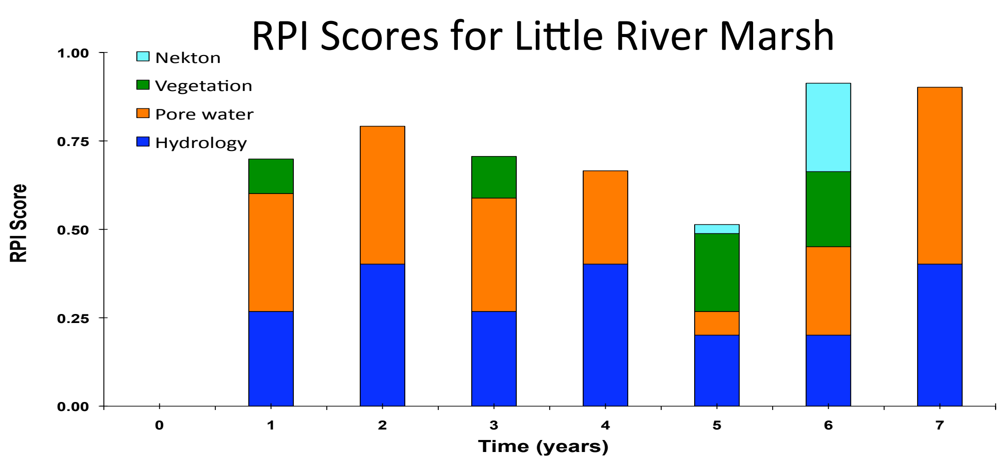


Net Gain in Ecosystem Services = $7200/ha/yr

100% = $14,400 /yr

39% = $5,600 /yr

89% = $12,800 /yr



Calculation of Value of Net Benefits from Ecosystem Services

RPI = 0.91 in Year 7;

Value lost due to impacts from tidal restriction = 41%

Year 7 value relative to reference marsh = 0.91%

SO . . Restored benefits = $14, 400/ha * 0.41 * 0.91 * 70 ha

= $376,000

OVER first 5 years (2001-2005) = $1.2 million
OVER next 6 years (2006-2011) = $2.2 million
Cost $1.3 million

Thank you