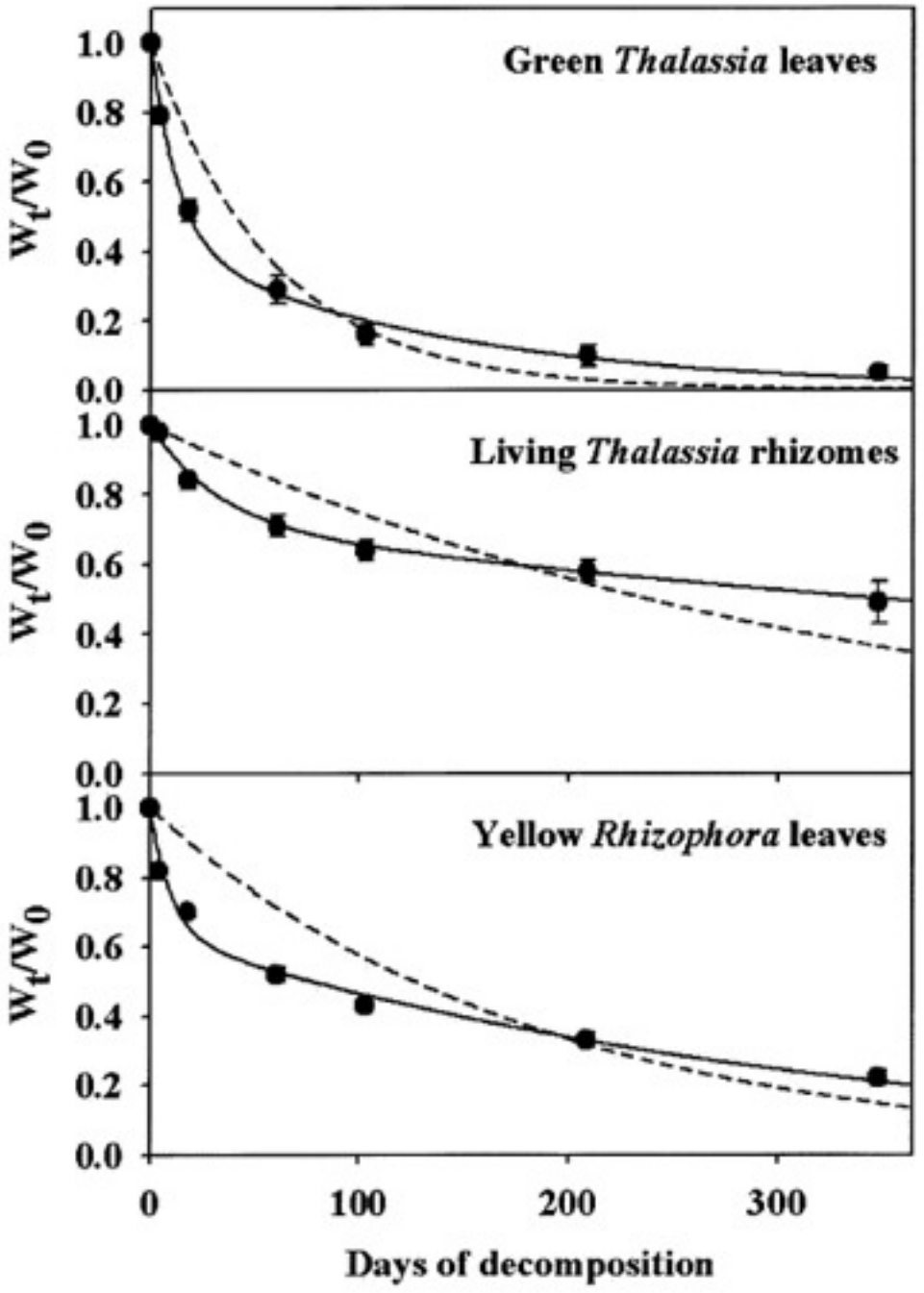
Towards predicting CO_2 emissions from damaged coastal ecosystems

Cath Lovelock and Jim Fourqurean

Most decomposition processes can be modeled as a simple exponential decay of one or more components. More labile pools are consumed more rapidly, and decomposition is generally faster in oxic environments.



Emissions model governing equations

$$TC_{org} = \sum_{i=1}^{n} C_{org(i)}$$

Where:

i = type of carbon (leaves, wood, stem, soil, etc)

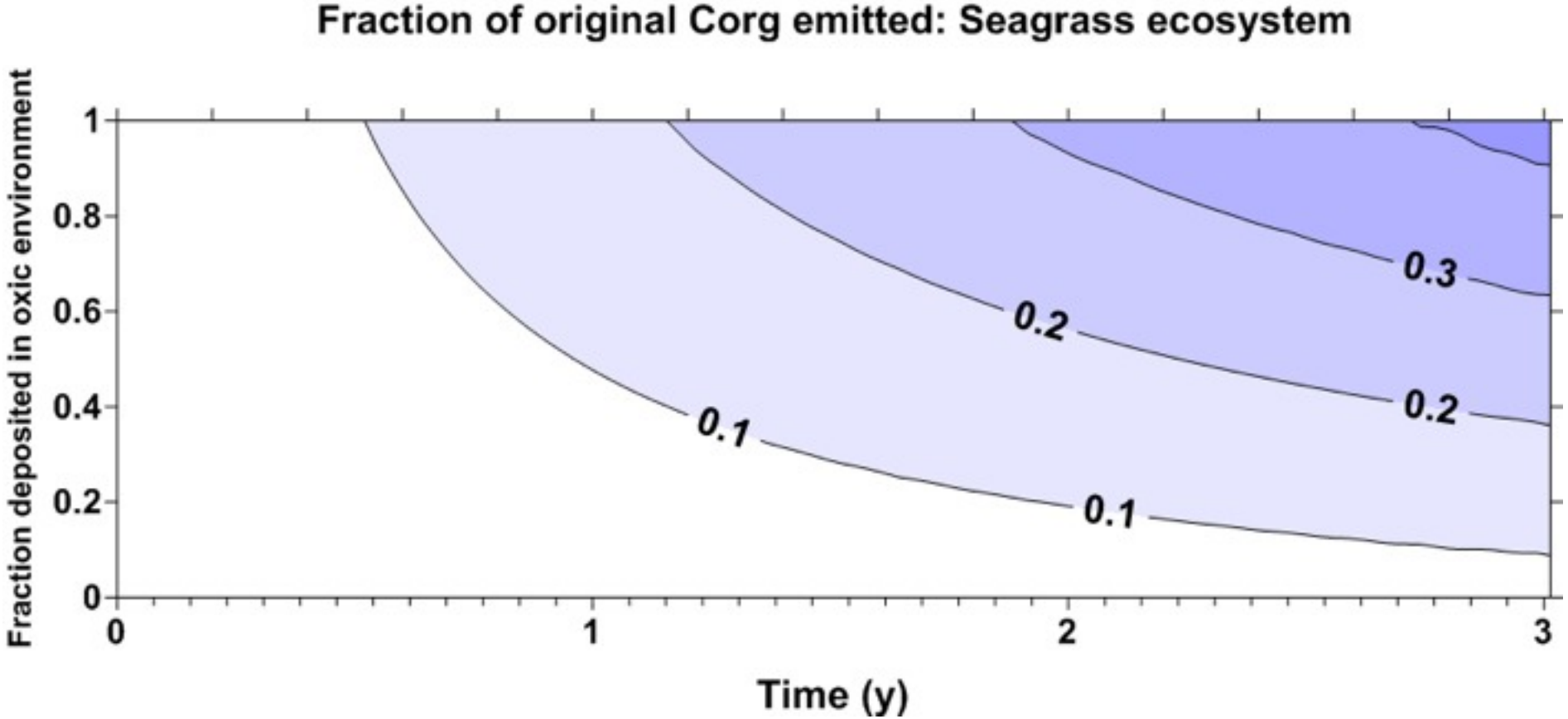
And:

$$C_{org(i)}(t) = \alpha C_{org(0)} e^{k_1 t} + (1-\alpha) C_{org(0)} e^{-k_2 t}$$

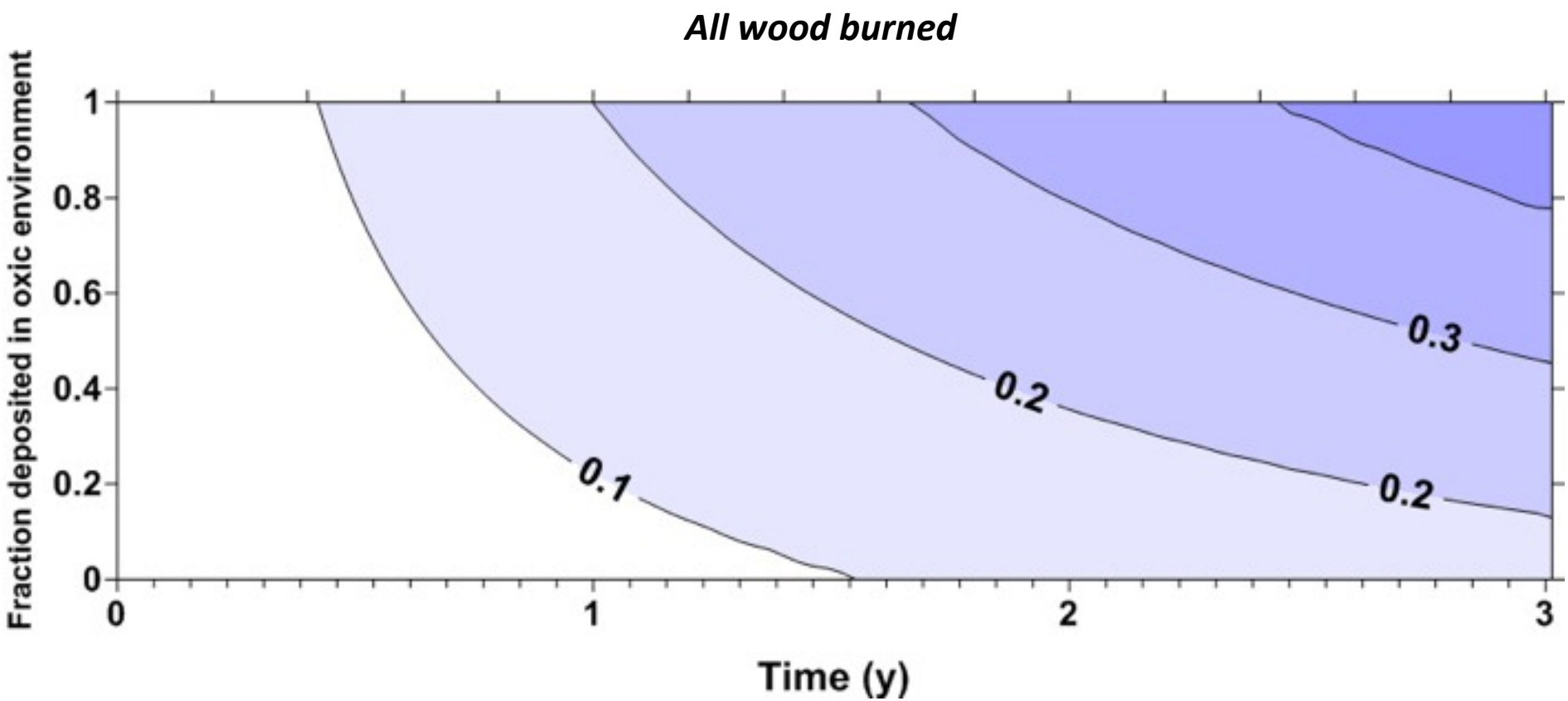
Where:

k_1 is decomposition rate in oxic environments, k_2 is decomposition in anoxic environments and α = fraction of C_{org} deposited in oxic environments

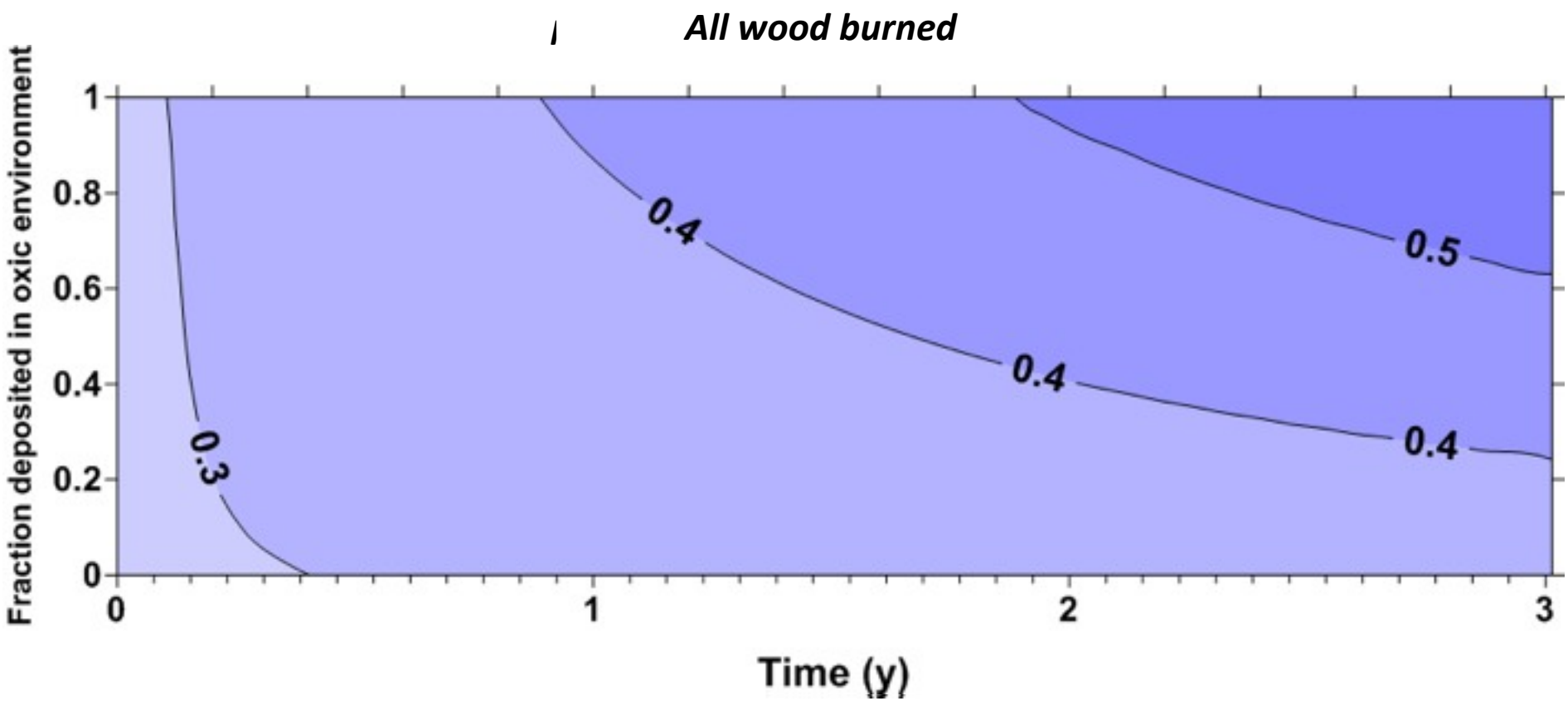
	Biomass component	Initial biomass ($Mg\ C\ ha^{-1}$)	k_{oxic} d^{-1}	k_{anoxic} d^{-1}
Seagrass				
	Aboveground biomass	0.8	0.02	0.01
	Belowground biomass	1.8	0.0032	0.0016
	Soil C_{org}	139.7	0.0005	0.00005
Tidal Marsh				
	Aboveground biomass	0.8	0.02	0.01
	Belowground biomass	1.8	0.0032	0.0016
	Soil C_{org}	139.7	0.0005	0.00005
Mangrove forest				
	Leaves	20	0.03	0.03
	Aboveground wood	200	0.0007	0.0004
	Coarse roots	80	0.0007	0.0004
	Fine roots	20	0.0007	0.0004
	Soil C_{org}	700	0.0005	0.00005


Fraction of original Corg emitted: Seagrass ecosystem
Fraction deposited in oxic environment
1
0.8
0.6
0.4
0.2
0
0
1
2
3
Time (y)
0.3
0.2
0.2
0.1
0.1

Fraction of C_{org} emitted from mangrove forest following loss

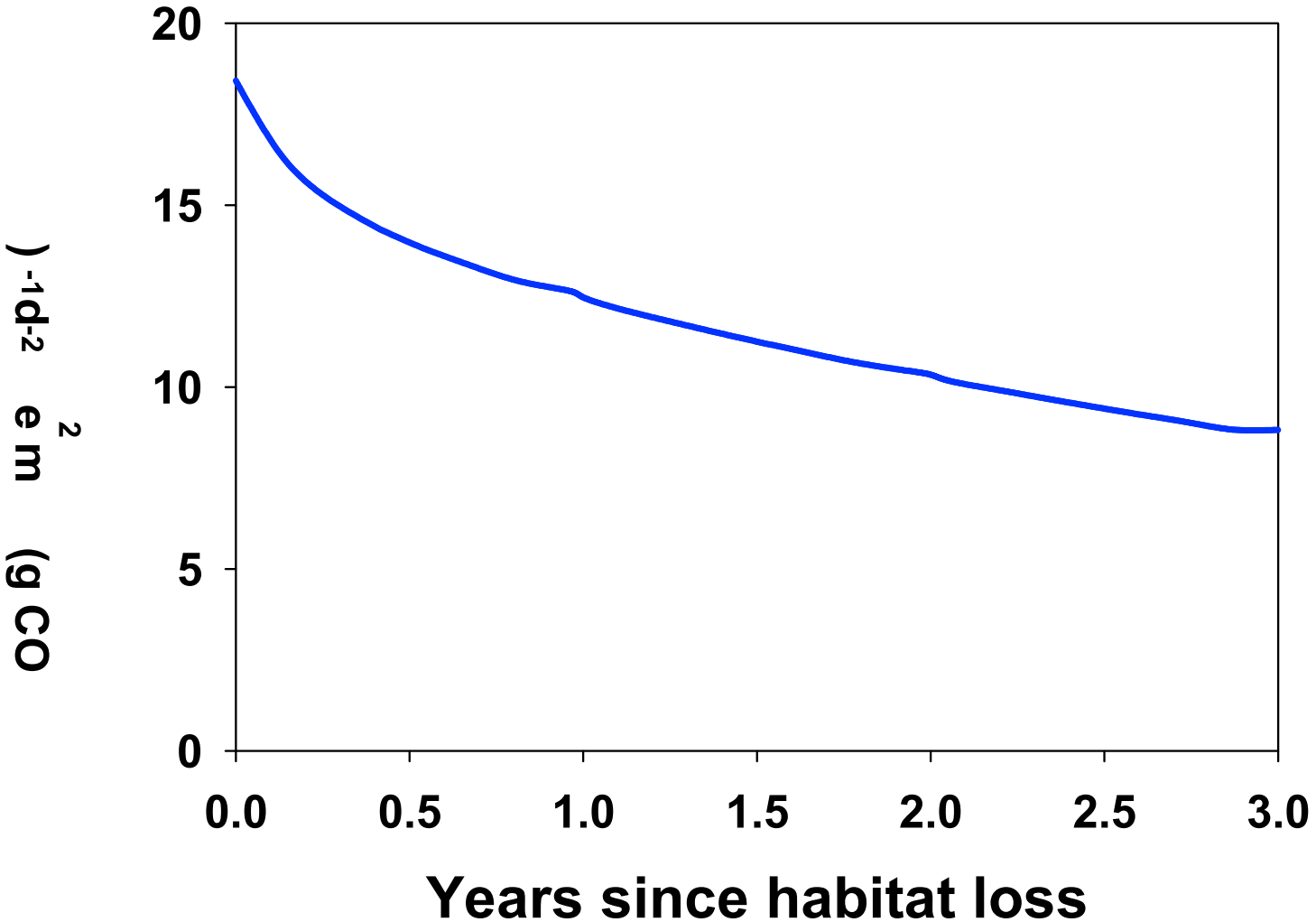


Fraction of C_{org} emitted from mangrove forest following loss



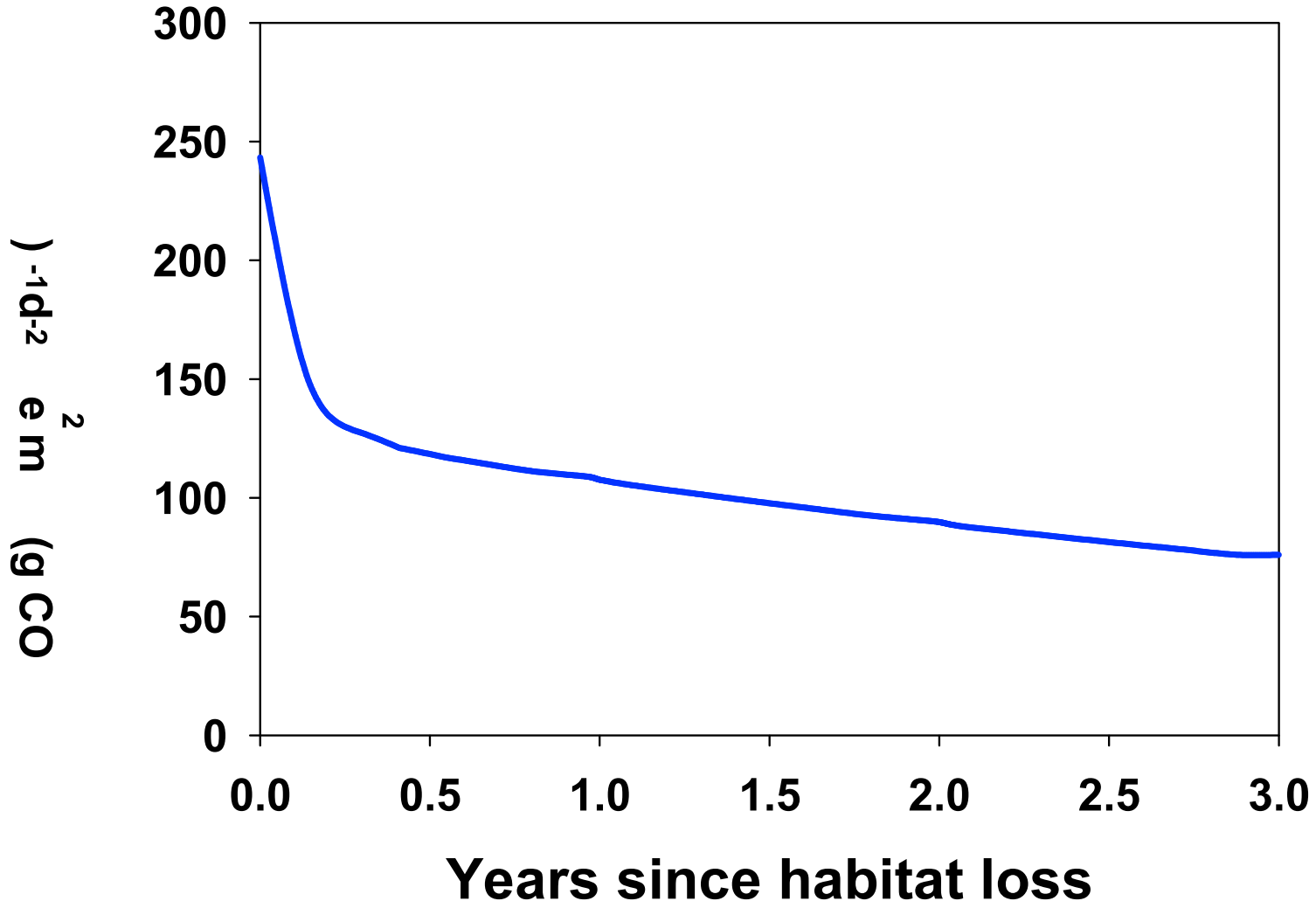
Time course of emissions from an average seagrass bed

(assuming 50% of C_{org} deposited in oxic environment)

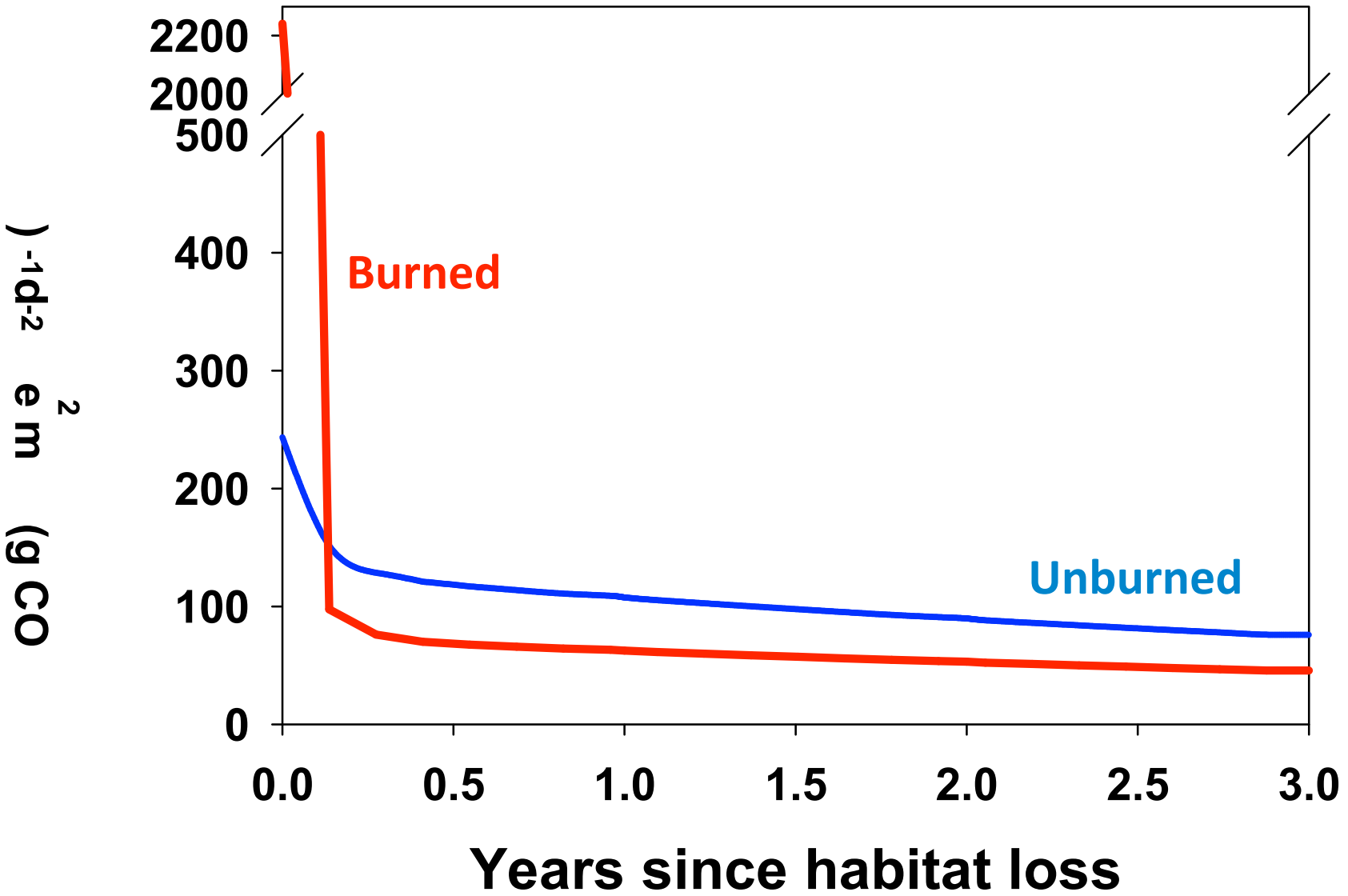


Time course of emissions from an average mangrove forest

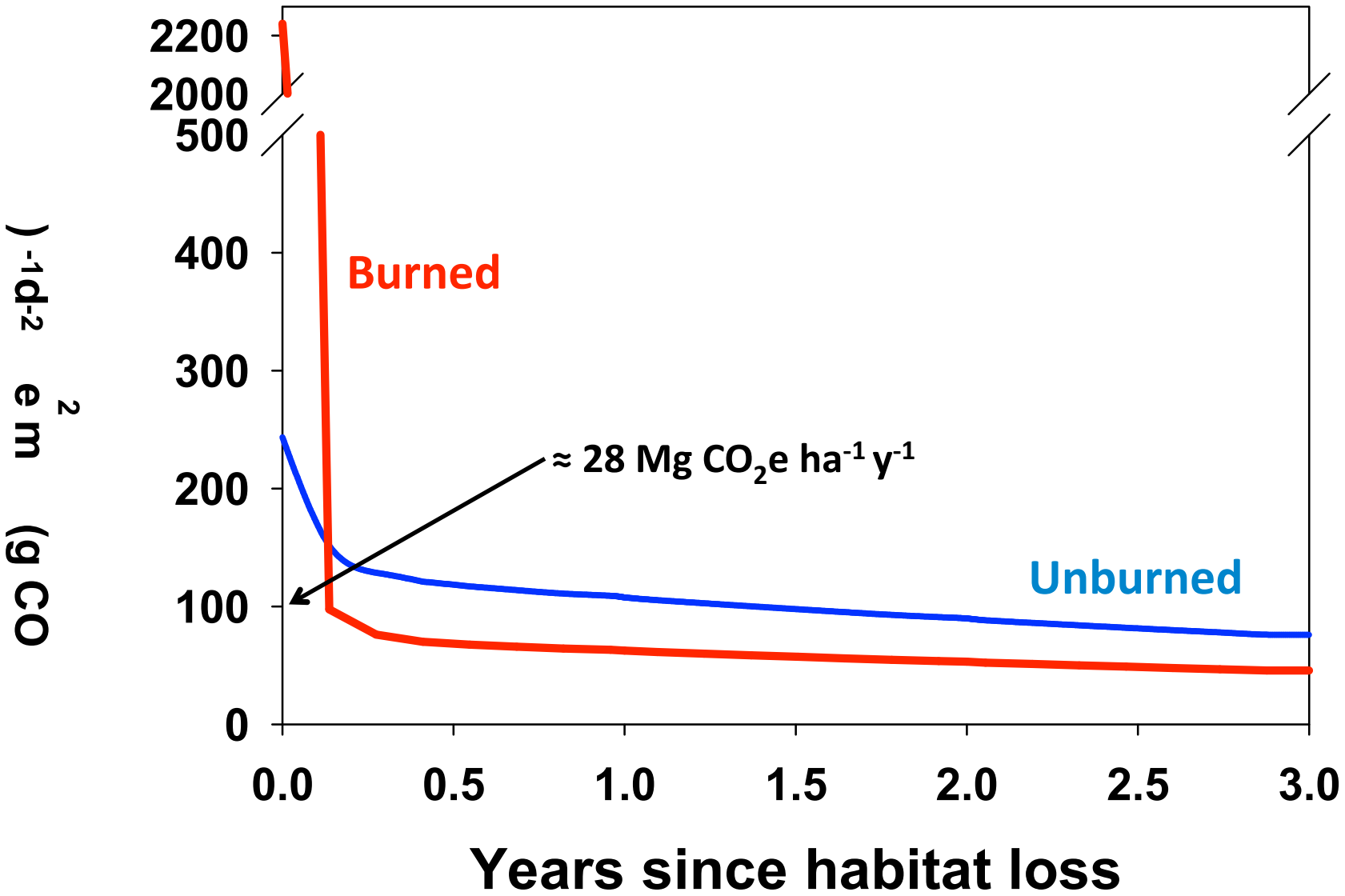
(assuming 50% of C_{org} deposited in oxic environment, no burning)



Effect of biomass burning on emissions trajectory, mangrove forest



Effect of biomass burning on emissions trajectory, mangrove forest



Measured rates of CO_2e emissions from destroyed habitats

Habitat	Modification	CO_2 efflux Mg ha-1 $year^{-1}$	Method	Reference
Mangrove, Belize	Cleared	29	CO_2 efflux	Lovelock et al 2011
Mangrove, Honduras	Forest damaged by hurricane	15	Inferred from peat collapse	Cahoon et al. 2003
Mangrove, Australia	Shrimp pond	17.5 (22-50)	CO_2 efflux	Burford and Longmore 2001
Rainforest, Indonesia	Drained for agriculture	32	Inferred from peat collapse and measured as CO_2 efflux	Couwenburg et al. 2010 and references therein
Tundra, Alaska	Thawed (vegetation intact)	1.5-4.3	Net CO_2 exchange	Schuur et al. 2009