CARBON FARMING

Increasing Carbon Capture on California's Working Lands

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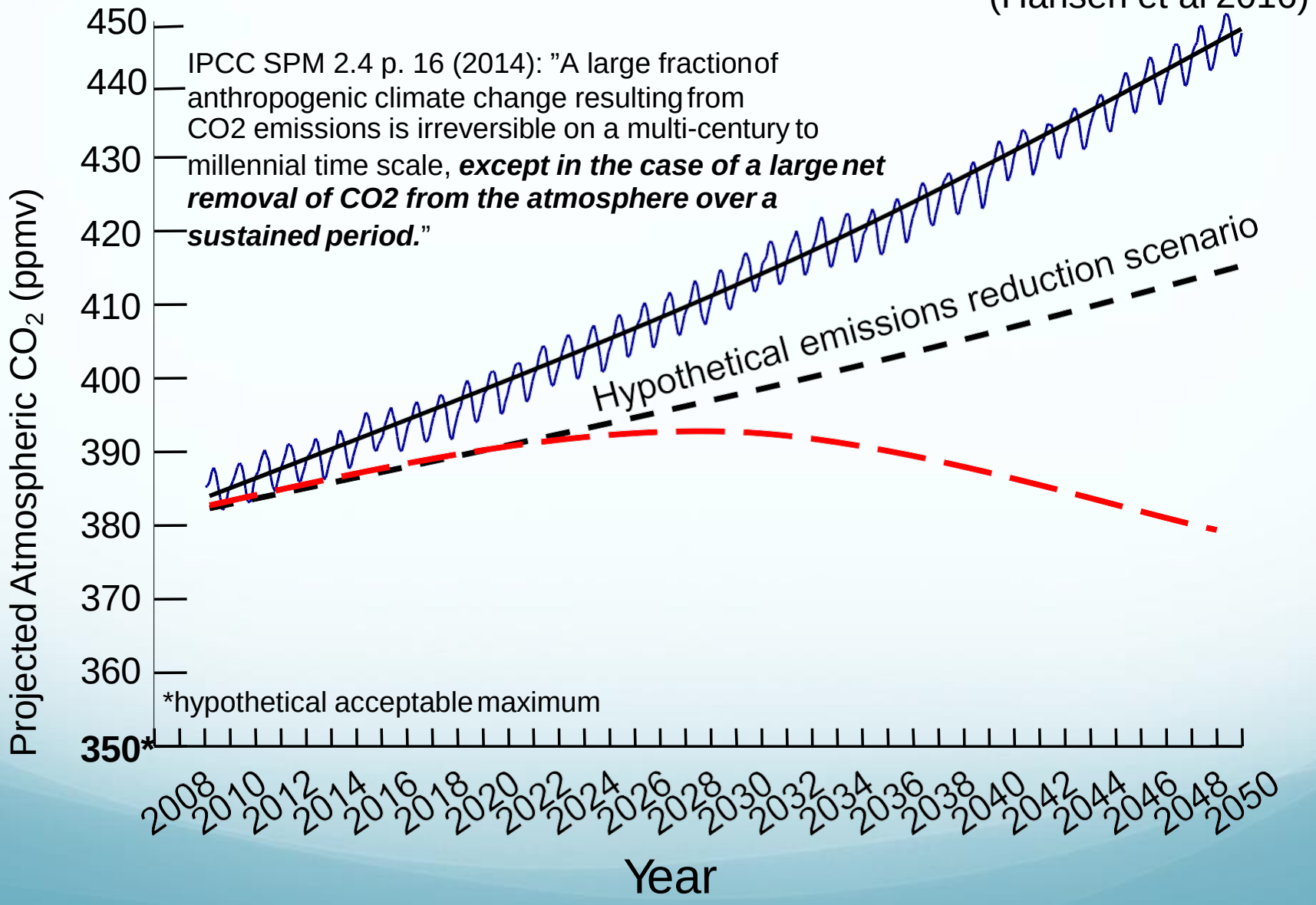
Nicasio Native GrassRanch

We can ***only*** meet our GHG reduction goals by investing in our **soils and working lands** as major sinks for atmospheric carbon.

(Hansen et al 2016)



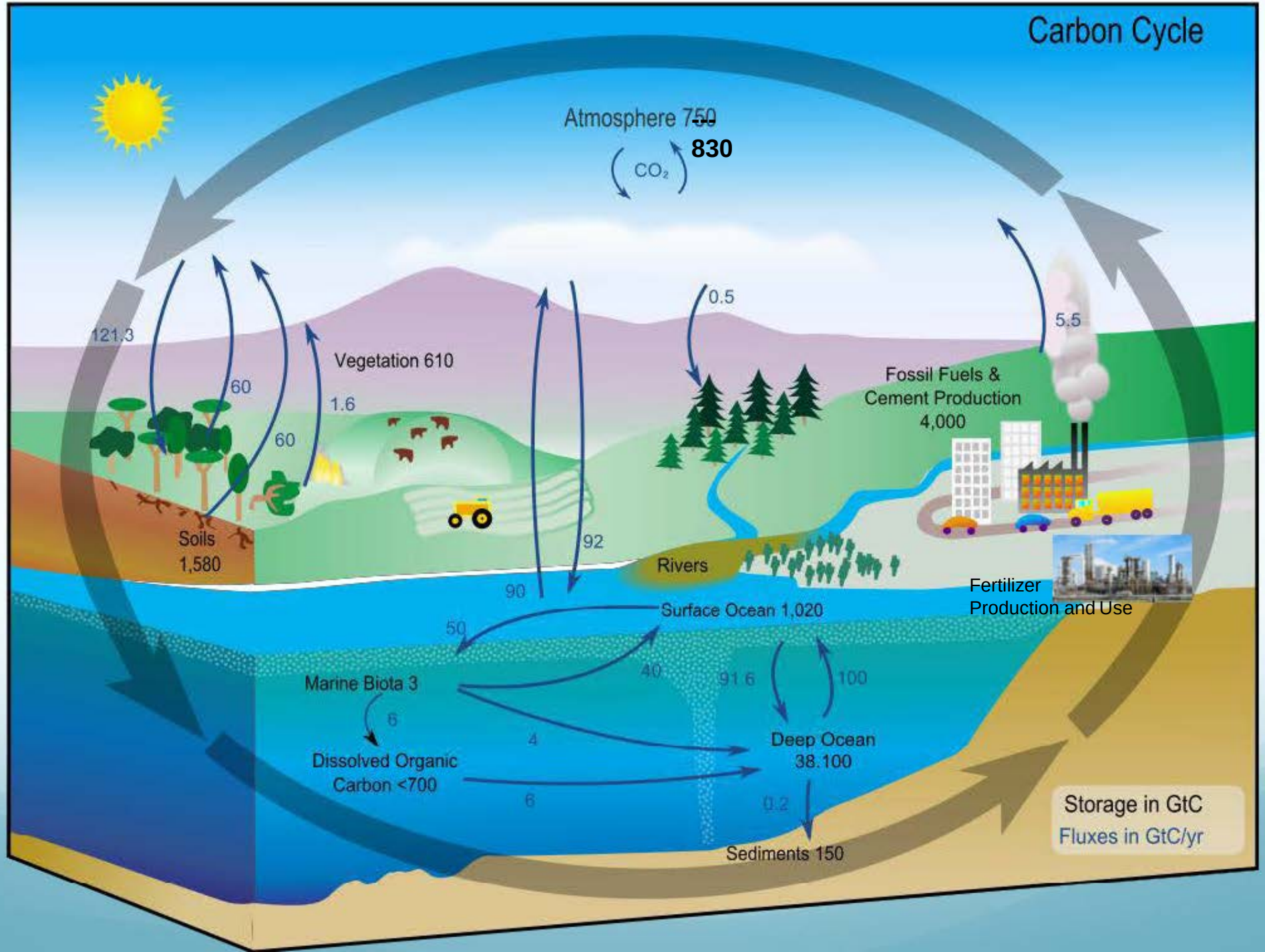
The ‘4 per Thousand’ Initiative

Ministry of Agriculture, Agrifood and Forestry, France:

Increasing global soil organic carbon by 0.4% annually would offset **all** global CO2 emissions

- the “*4‰ Initiative: soils for food security and climate*” aims to show that **food security and combating climate change are complementary** and to ensure that agriculture provides solutions to climate change. This initiative consists of a voluntary action plan under the **Lima-Paris Agenda for Action (LPAA)**.

- http://agriculture.gouv.fr/agriculture-et-foret/environnement-et-climat

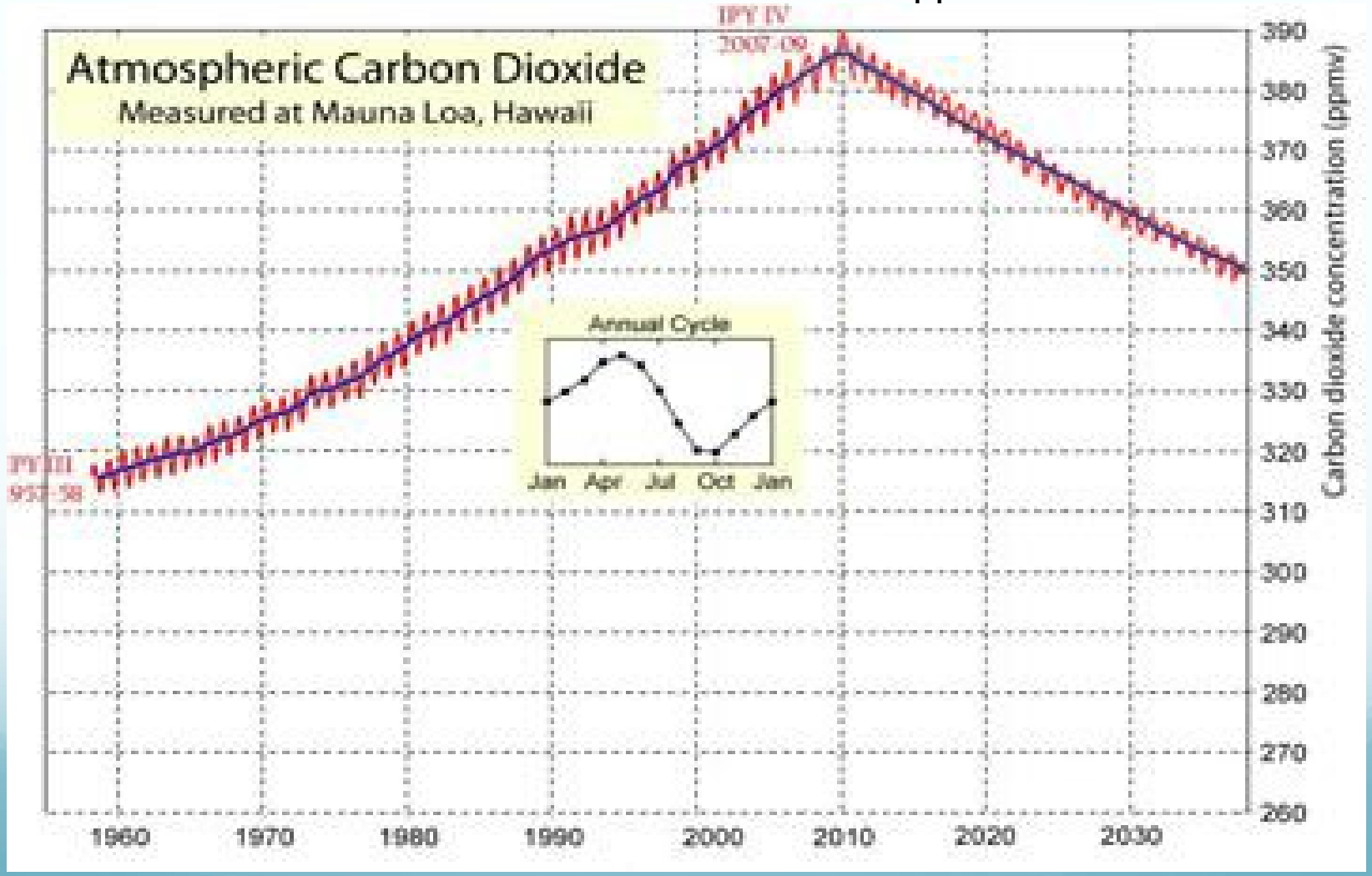

Carbon Cycle
Atmosphere 750
830
CO2
121.3
60
60
Vegetation 610
1.6
0.5
5.5
Fossil Fuels &
Cement Production
4,000
Soils
1,580
92
90
Rivers
Fertilizer
Production and Use
Surface Ocean 1,020
50
Marine Biota 3
40
91.6
100
6
4
Deep Ocean
38,100
Dissolved Organic
Carbon <700
6
0.2
Sediments 150
Storage in GtC
Fluxes in GtC/yr

"… 100 GtC (47 ppm CO2) extraction in the 21st century …is comparable to net emissions from historic deforestation and land use……"

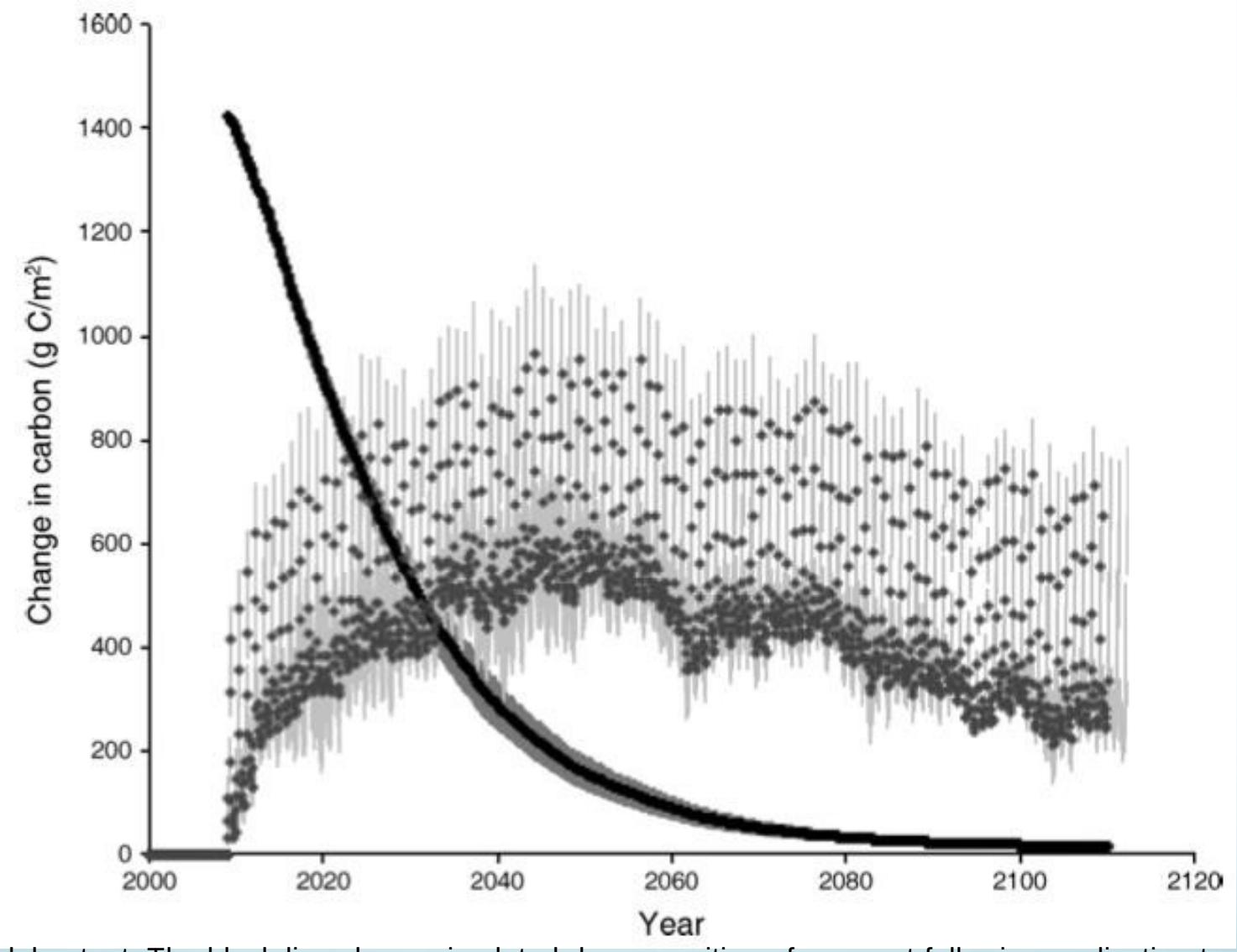
Hansen et al 2016

Measured effect of anthropogenic forcing of atmospheric C, with hypothetical effect of anthropogenic forcing of soil organic C at global scale

400 ppm



Marin Carbon Project, 2008
H1: Management can increase soil carbon
and: we can measure it

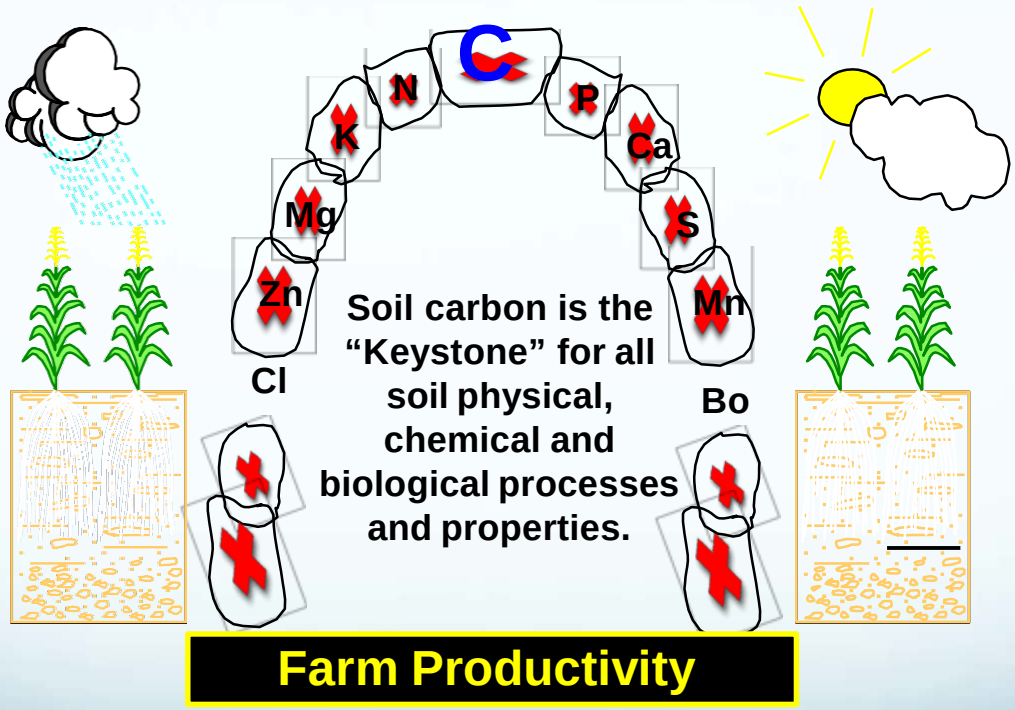


DayCent model output: The black line shows simulated decomposition of compost following application to grasslands. Gray circles show the monthly change in total ecosystem carbon, *not including compost carbon*. Values are averages across site characterizations; standard error bars in light gray.

Ryals et al, 2015. Ecological Applications, 25(2): 531–545.

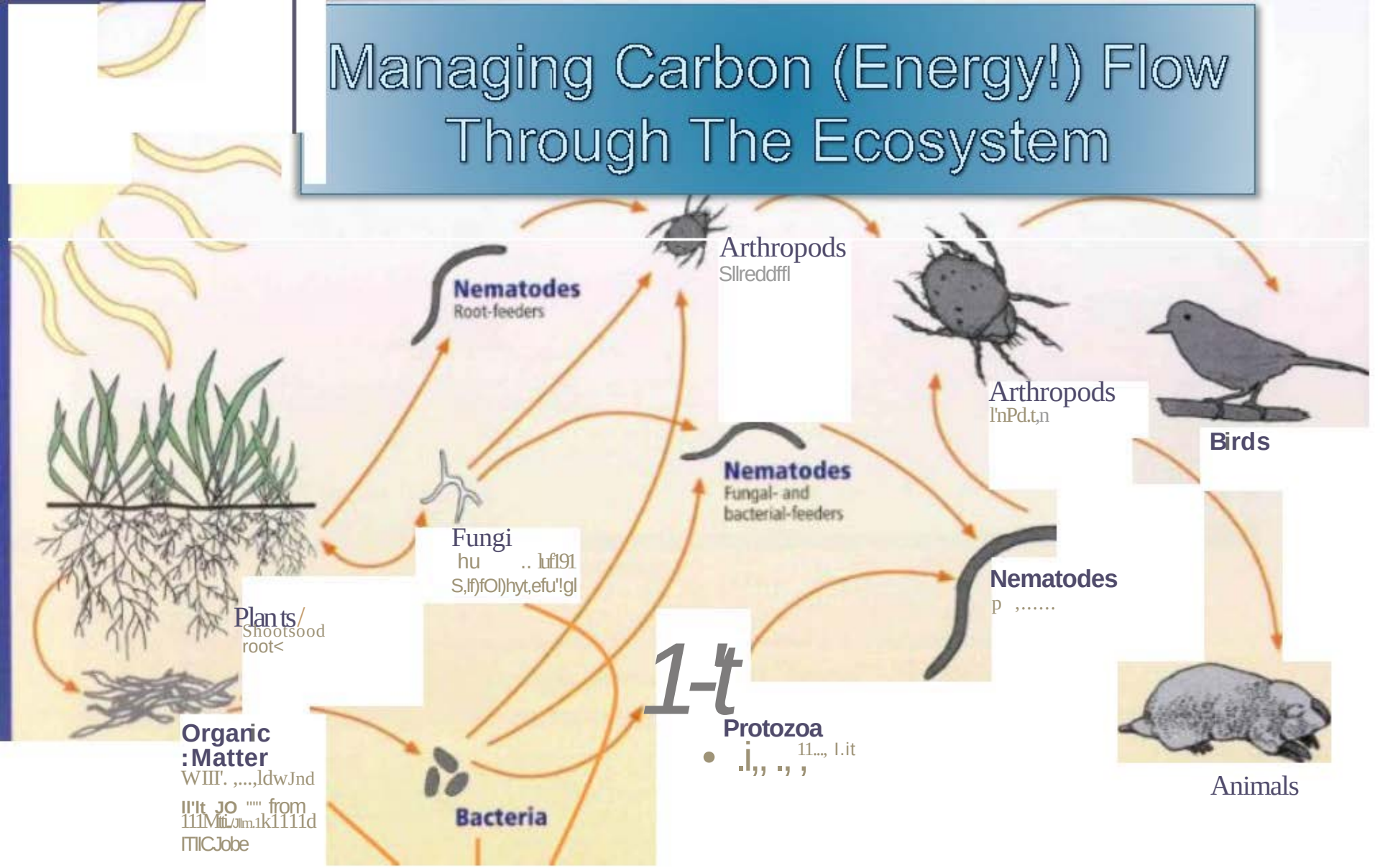
Carbon:

the key to agricultural productivity and resilience



Credit: Dr. D.C. Reicosky, ARS, Morris, MN

Managing Carbon (Energy!) Flow Through The Ecosystem



First trophic level:
PholDS)Oth

Second trophic level·
omposers Mutua' u
Pathcigi>,ls.P.lras
Root·IH<ler\

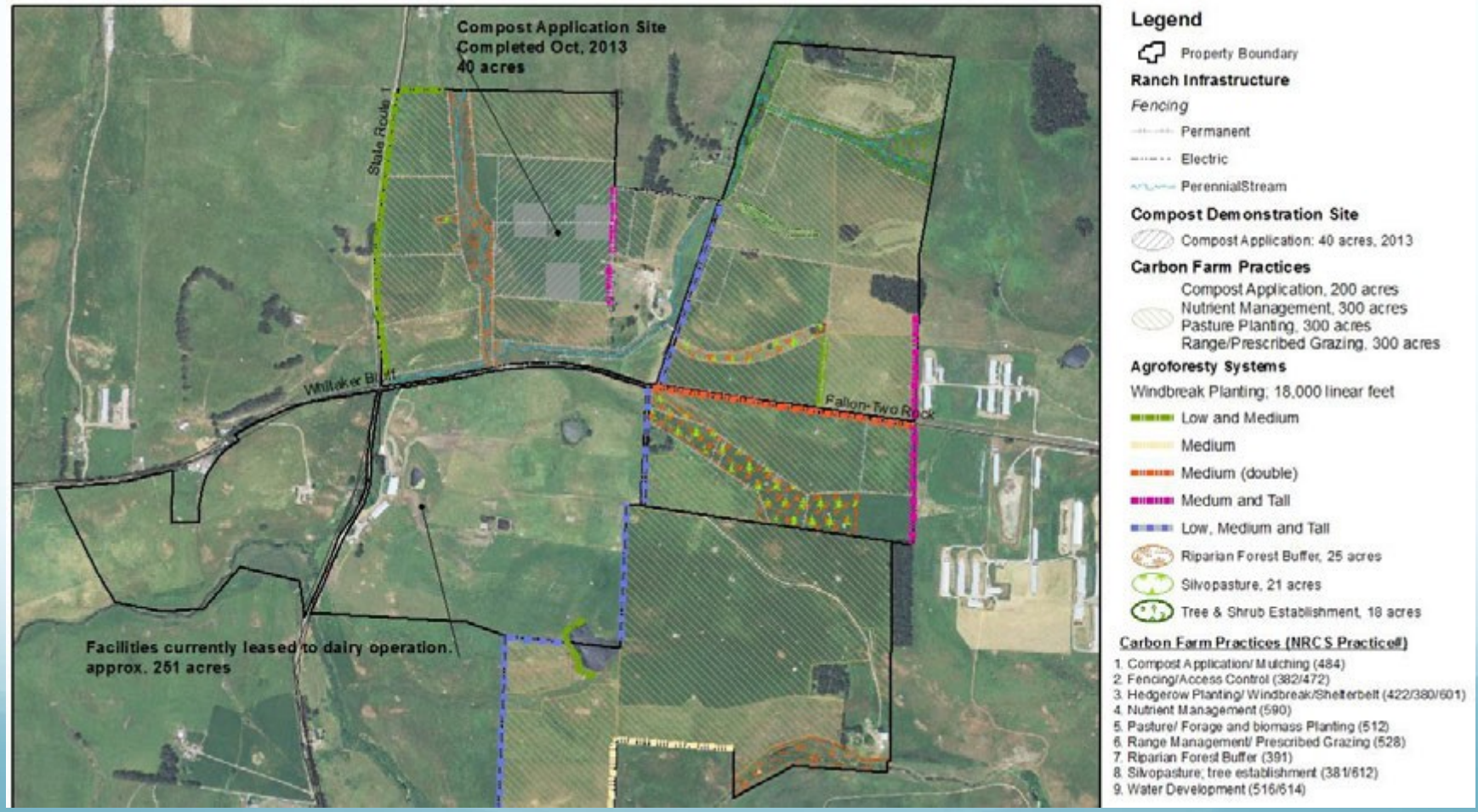
Third trophic level:
Shredder
s
Predators

Fourth trophic level:
Higm'f level j)ffliatOf

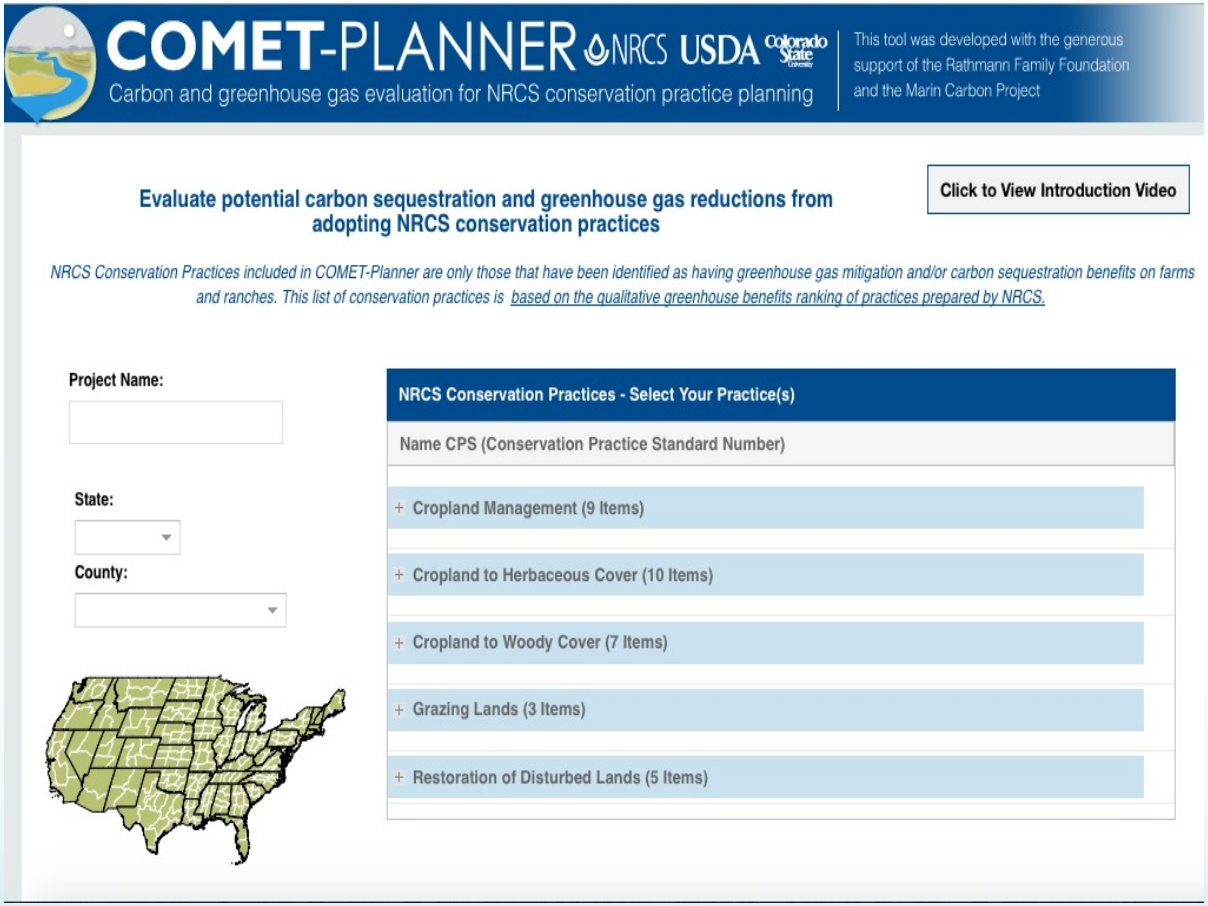
Fifthandhigher
trophiclevels:
H,gt-fl ,-1'! predator\

Carbon Farm Planning

Identifying climate-beneficial practices and potentials based on whole-farm assessment.



Carbon Farming:
Quantifying On-farm Carbon Capture Potential



And LOCAL DATA, where available…
COMPOST: R.Ryals et al 2013; M.DeLonge et al 2013
CREEK CARBON: D.Lewis et al 2015

Estimated CO2e Reduction/Sequestration Potential, Modoc Ranch

Practice	Average Annual CO2e Sequestration (Mg)	20 yr CO2e Sequestration
Rangeland Compost	167	31,826
Cropland Compost (590)	1,097	21,938
Shelterbelts (380)	20	404
Riparian Restoration*	368*	7353*
Prescribed Grazing (528)	790	15,800
Range Planting (550)	720	14,400
Minimum-Tillage (345)	104	2,080
Silvopasture (381)	94	1,880
Irrigation System (443)	780	15,600
Totals	**4,140**	**111,581**

Estimated Additional Annual Soil Water Holding Capacity Modoc Ranch With Carbon Farm Plan Implementation, Year 20

PRACTICE	DESCRIPTION	20 YEAR SOM INCREASE (Mg)	ANNUAL WHC INCREASE BY YEAR 20 (AF)
Compost application on Rangeland (NRCS practice standard in development)	Application of 1/4" of compost to 1600 acres of permanent pasture.	17344.09	158.99
Compost application on Cropland (590)	Application of compost to 537 acres of cropland to 5% SOM	11,955.00	109.59
Shelterbelts (380)	6.78 miles (16.44 acres) of 20' wide shelterbelts	98.35*	0.90*
Prescribed Grazing (528)	Grazing management to favor perennials and improve production on 4411 acres	8,610	78.93
Riparian Restoration	32.36 acres of riparian system along 4.45 miles	1,048.00*	9.60
Minimum-Tillage (345)	Conversion of tilled crop fields to minimum tillage on	1,134	10.39
Silvopasture (381)	Establish trees on approximately 134 acres of pasture	270**	2.35
Conversion of flood irrigation to pipe irrigation (443)	Conversion of flood to pipe irrigation on 1,000 acres permanent pasture	8,501.00	77.93
Range Planting (550)	No-till interseeding of forage species in irrigated pasture within the Saline Bottom ecological site (2,107 acres)	7,847.00	71.93
TOTAL		64,274.44	521.63

Carbon Farming:
Climate-Beneficial Agriculture

Using published (Wiedemann et al 2015) on-farm GHG emission values for wool production, implementation of this Ranch's Carbon Plan would offset 6 to 9.5 times the GHG emissions associated with its wool production each year.

Carbon Farming provides a robust framework for a 'Climate-Beneficial' agriculture.

The Carbon-Soil-Water-Climate Connection

If California's working lands, i.e., 46 million acres of grasslands, pastures and arable lands, achieved even a 1% increase in SOC (from 1% to 2%) in the plow layer alone, the associated water holding capacity increase would be roughly 7.6 million acre feet (7.7 Folsom Reservoirs) and the CO2e sequestered would be 1.5 Billion metric tons (eq: 3,472,817,103 barrels of oil)

Across 8 million ***arable*** acres of CA alone, this represents 80 million metric tons of SOC, or 293 million metric tons of CO2e (eq: 185,216,912 barrels of oil) and 1.3 million acre feet (1.4 Folsom Reservoirs) of water.

(Recall: the French 4%% Initiative calls for an ***annual*** SOC increase of 0.4%)

Assumptions:

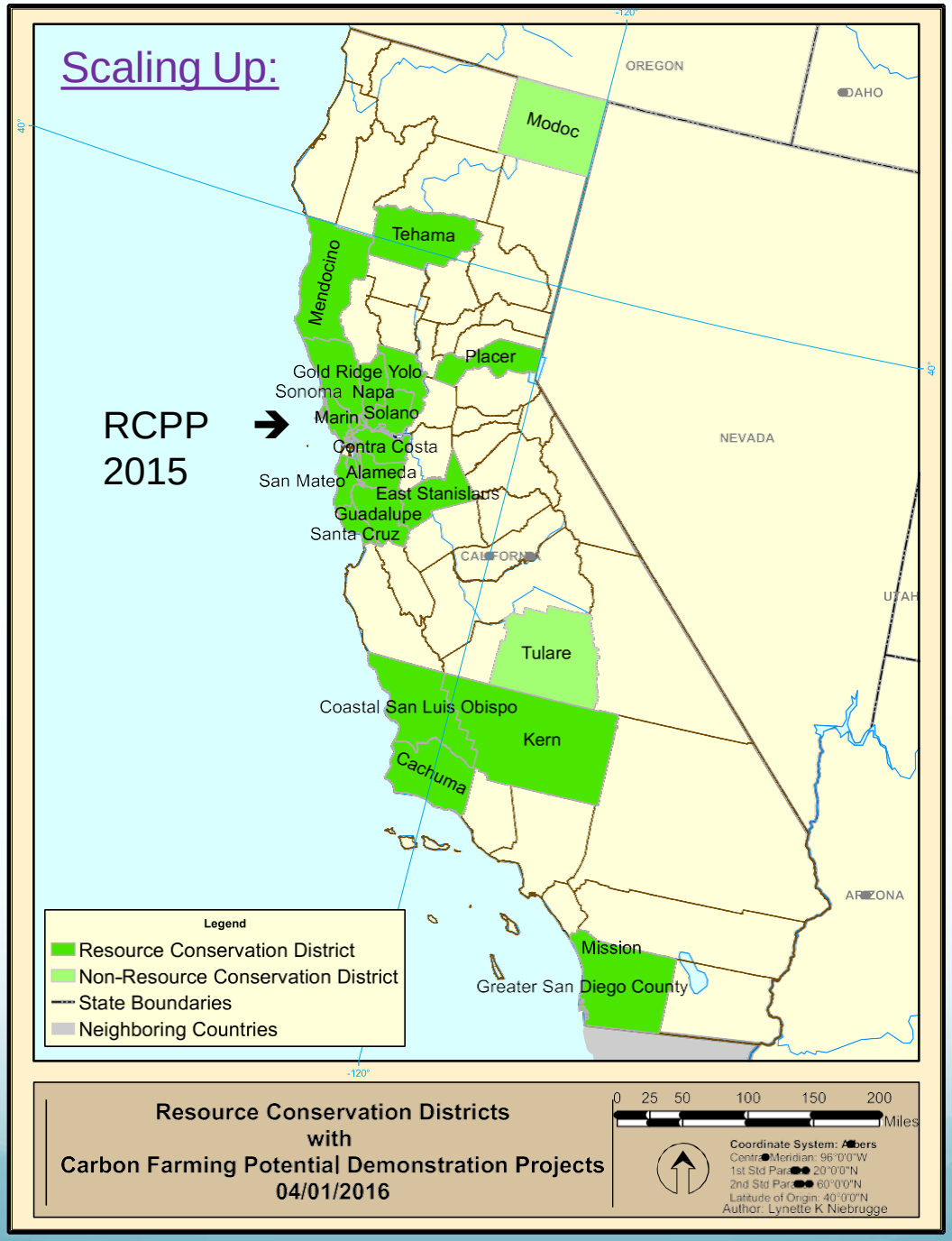
based on the plow layer (top 6.7" of soil) only; including deeper soil strata will increase potentials accordingly;

1% increase in SOM results in 1 acre-inch increase in soil water holding capacity per acre;

1% increase in SOC represents 2% increase in SOM;

1 metric ton (2,200 lbs) of soil C represents 3.67 metric tons of CO2e;

1% increase in (plow layer only) SOC is about 10 short tons or 9 metric tons SOC/acre.


Scaling Up:
RCPP 2015
OREGON
IDAHO
NEVADA
CALIFORNIA
UTAH
ARIZONA
Modoc
Tehama
Mendocino
Placer
Gold Ridge Yolo
Sonoma Napa
Marin Solano
Contra Costa
San Mateo Alameda
East Stanislaus
Guadalupe
Santa Cruz
Tulare
Coastal San Luis Obispo
Kern
Cachuma
Mission
Greater San Diego County
Legend
Resource Conservation District
Non-Resource Conservation District
State Boundaries
Neighboring Countries
Resource Conservation Districts
with
Carbon Farming Potential Demonstration Projects
04/01/2016
0 25 50 100 150 200
Miles
Coordinate System: Albers
Central Meridian: 96°0'0"W
1st Std Parallel: 20°0'0"N
2nd Std Parallel: 60°0'0"N
Latitude of Origin: 40°0'0"N
Author: Lynette K Niebrugge

Good News: We- ***can*** meet our GHG reduction goals ***if*** we dramatically reduce emissions ***and*** seriously invest in our **soils and working lands** as major ***-beneficial-*** sinks for atmospheric carbon.

Photo: Abe Collins, CarbonFarmersofAmerica.org

www.carboncycle.org
www.MarinCarbonProject.org

CO2e Sequestration Potential Cachuma Ranch, Santa Barbara

(1 Mg = 1 Metric Ton)

Practice	Average Annual CO2e Sequestration	20 yr CO2e Sequestration	CO2e Sequestration at Maturity
Rangeland Compost	638 Mg	98,847 Mg	162,619 Mg (30 years)
Cropland Compost (590)	2,060 Mg.	23,200 Mg	43,374 Mg at 5% SOM
Shelterbelts (380)	98 Mg	1,960 Mg	7,840-19,260 Mg at 80 years.
Hedgerows (422)	6 Mg	120 Mg	120 Mg
Prescribed Grazing (528)	1,460 Mg	29,200	29,200
Riparian Restoration	410 to 1,725 Mg	6,144-25,867 Mg at 15 years	18,431-77,613 Mg at 45 years.
No Till (329)	39 Mg	780 Mg	780 Mg
Minimum-Tillage (345)	100 Mg	2,000 Mg	2,000 Mg
Silvopasture (381)	660 Mg	13,200 Mg	214,000 Mg
Nutrient Management (590)	610 Mg	12,200 Mg	48,800
Totals	**6,081- 7,396 Mg**	**187,651 - 207,374 Mg**	**527,164-597,766 Mg**

Estimated Additional Soil Water Holding Capacity With Carbon Farm Plan Implementation, Cachuma Ranch, Santa Barbara County, CA

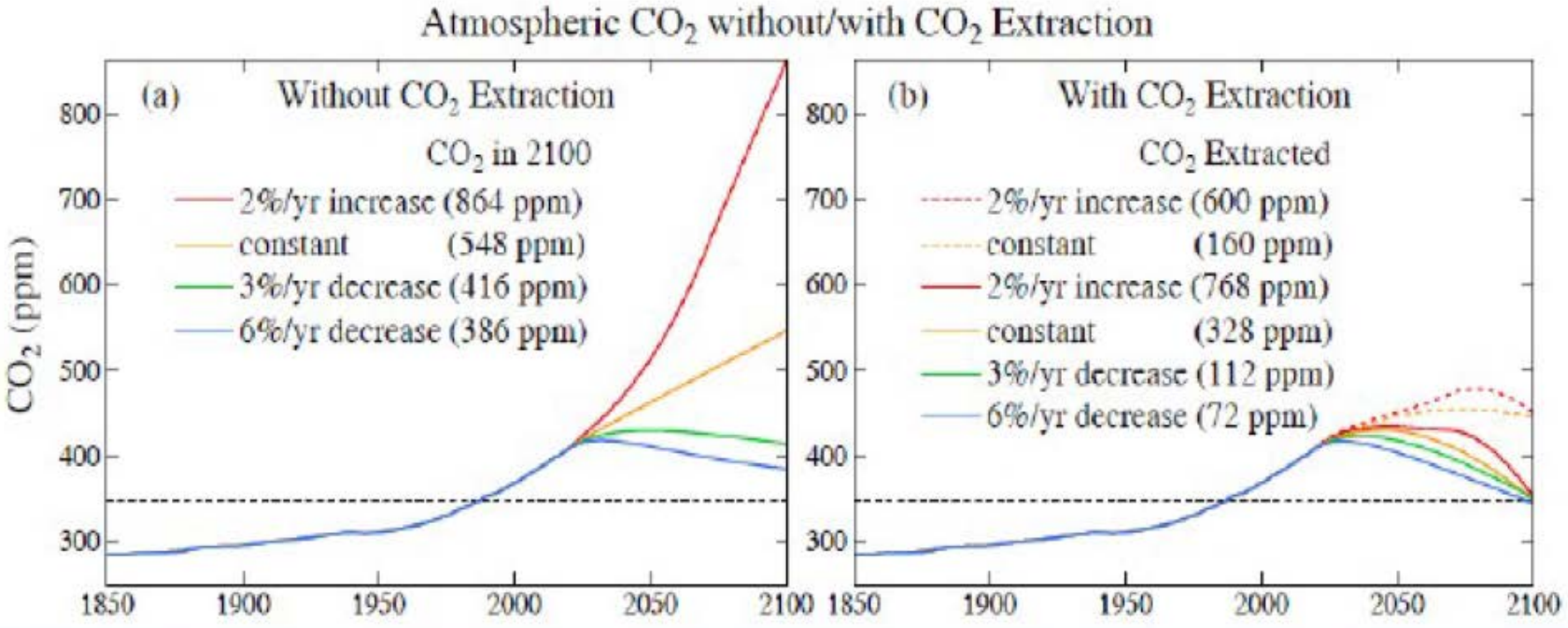
Table 15. Estimated Additional Soil Water Holding Capacity (WHC) With Plan Implementation

PRACTICE	DESCRIPTION	20 YEAR SOM INCREASE (Mg)	ANNUAL WHC INCREASE BY YEAR 20 (AF)
Compost application on Rangeland (NRCS practice standard in development)	Application of 1/4" of compost to 4300 acres of permanent pasture.	53867 Mg	493.78
Compost application on Cropland (590)	Application of 1" of compost to 617 acres of cropland.	23637.05 Mg	216.67
Shelterbelt (380)	13.6 miles (90 acres) of 50' wide shelterbelts	1068.12 Mg	9.79
Prescribed Grazing (528)	Grazing management to favor perennials and improve production on 7300 acres.	15912.80 Mg	145.86
Riparian Restoration	Restoration of 94 acres of riparian system along 7.75 miles of stream corridor Planting of native trees and shrubs.	3043.23 Mg (derived from Lewis et al 2015)[1]	27.89
No-till system-Tillage Management (512).	Convert tilled forage fields to permanent pasture; minimize tillage on croplands	425.06 Mg	3.89
Minimum-Tillage (345)	Conversion of tilled crop fields to minimum tillage on	1089.91 Mg	9.99
Silvopasture (381)	Establish trees on approximately 1,000 acres) of treeless pasture.	4027.24 Mg (derived from Gaman 2008)	36.91
TOTAL		103,070.36	917.52

[1] Lewis et al 2015 model coefficients indicate annual increases of soil carbon = 0.2 kg/m^2. 1 acre = 4046.85642 m^2.

34 NRCS Carbon Farming Practices: COMET-Planner.com

Cropland Management
Conventional Tillage to No-Till
Conventional Tillage to Reduced Till
Improved Nutrient Management
Conservation Crop Rotation
Cover Crops
Strip cropping
Mulching
Combustion System Improvement (Improved Fuel Efficiency of Farm Equipment)
Cropland to Herbaceous Cover
Conservation Cover
Forage and Biomass Planting
Herbaceous Wind Barriers
Vegetative Barriers
Riparian Herbaceous Cover
Contour Buffer Strips
Field Border
Filter Strip
Grassed Waterway
Cropland to Woody Cover
Tree/Shrub Establishment
Windbreak/Shelterbelt Establishment
Windbreak/Shelterbelt Renovation
Riparian Forest Buffer Establishment
Hedgerow Planting
Alley Cropping
Multistory Cropping
Grazing Lands
Range Planting
Silvopasture Establishment on Grazed Grasslands
Restoring Degraded Rangeland with Compost Addition
Prescribed Grazing
Restoration of Disturbed Lands
Land Reclamation – Abandoned Mine Land
Land Reclamation – Currently Mined Land
Land Reclamation – Landslide Treatment
Critical Area Planting
Riparian Restoration



(a) Atmospheric CO2 emission scenarios

(b) Atmospheric CO2 including effect of CO2 extraction that increases linearly after 2020 (after 2015 in +2%/year case).
(1 ppm is ~2.12 GtC).

Hansen et al 2016

Earth Syst. Dynam. Discuss., doi:10.5194/esd-2016-42, 2016