CARB Natural and Working Lands Modeling Framework

AB 1757 NWL EXPERT ADVISORY COMMITTEE MEETING

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Role and Scaling of Carbon Dioxide Removal (CDR)

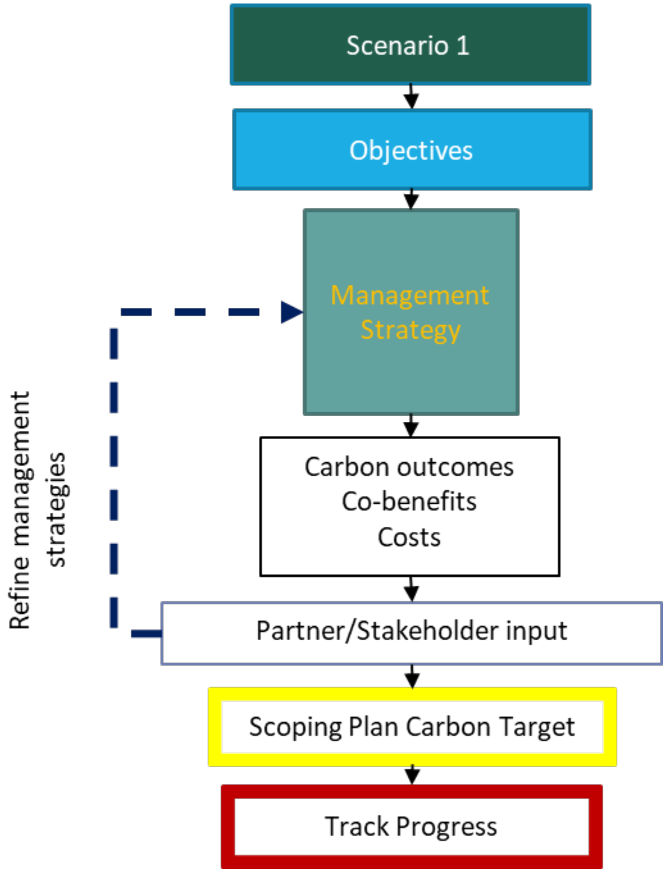
AB 32 GHG Inventory Sectors: Significantly reduced, but some emissions remain

NWL a modest source

Need carbon dioxide removal to compensate for AB 32 GHG Inventory and NWL sectors

- **Role of CDR is reduced if:**
  - We reduce the emissions from the AB 32 GHG Inventory Sectors faster
  - NWL are able to become a sink

Scoping Plan Target Setting Approach



Definitions

Scenario: A set of objectives, management strategies, and mechanisms pathways

Objectives: A vision for the future of each landscape type. These can be broad, e.g., store more carbon, reduce fire risk, improve public health, and treat 1M acres. This is the narrative of the scenario.

Action: An individual activity on the ground like a prescribed burn, composting, wetland restoration, and conservation.

Management strategy: A statewide set of actions with detailed information on type, intensity, location, and timing of actions.

Scoping Plan Carbon Target: The amount of carbon stocks that are anticipated given the chosen scoping plan scenario. This target is in relative terms to a measurable moment in the past.

Scoping Plan Target

Action	SP Level of Action
Forest, shrubland, and grassland fuel reduction and restoration (acres/year)	2,300,000
Regenerative agriculture and cropland conservation above BAU (acres/year)	150,000
Urban Forest investment increase above current investment (annual % increase)	200%
Defensible space establishment in wildland urban interface (properties/year)	50,000
Delta wetland restoration (total acres by 2045)	60,000
Desert Conservation above current conservation (acres/year)	15,000

Annual investment in NWL climate action above what we already spend = $6.5Billion/year from 2025 to 2045

NWL Outcomes in the Scoping Plan

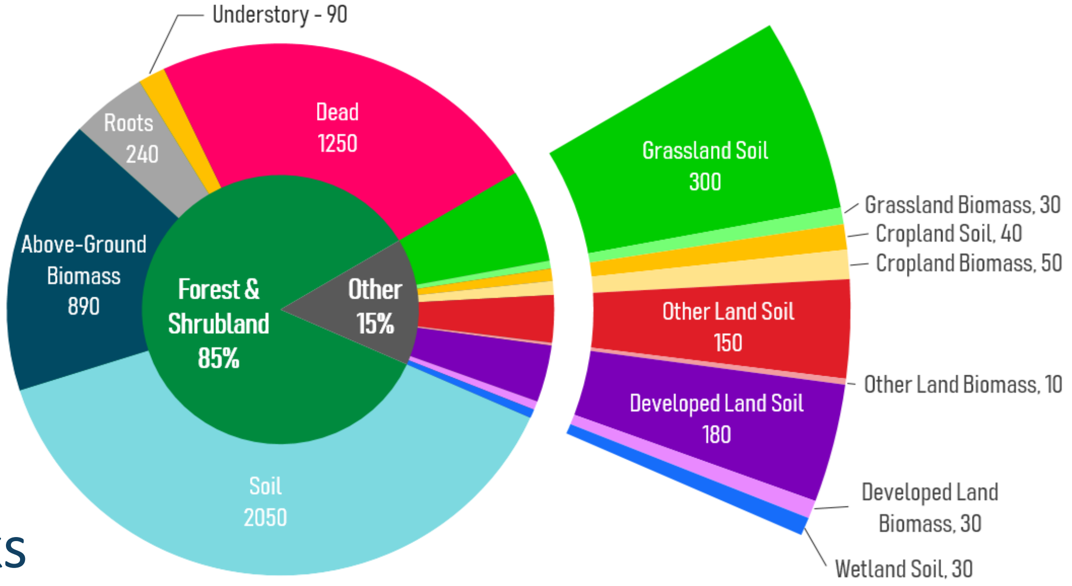
- Meets the NWL Target in 2022 SP to keep carbon stock losses to 4% or less by 2045*
- Reduces NWL emissions to an average emission rate of 7 MMT CO_2e/year across all lands**
- Provides additional carbon dioxide removal from NWLs, including at least 1.5 MMT CO_2/year
- Provides water/air quality benefits, reduced pesticide exposure, increased biodiversity, increased resiliency, and other benefits

*From 2014 NWL total carbon stock levels identified in CARB's NWL Ecosystem Inventory
**Without implementation of the Scoping Plan, NWLs projected to have emissions of 8.5 MMT CO_2e/year

Modeling

- Why Model?
  - Estimate the future trajectory of carbon sources, sinks, and stocks within the NWL sector
  - Assess how action may change outcomes
  - Cumulative impacts
  - Custom scenarios (climate/policy/management)
- Work is being prioritized by current carbon stocks

2018 CARB NWL Inventory



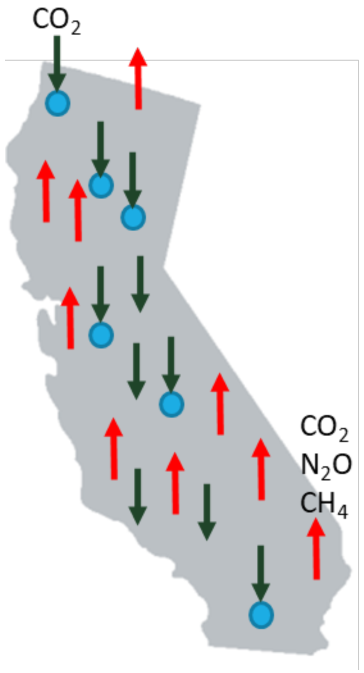
Objectives of NWL Modeling (1)

Quantify statewide carbon dynamics (both where climate action is and isn't occurring)

Project level accounting (the benefit of climate action)

Focus is on ensuring individual sites/projects provide GHG reductions or removals

But what about the cost of inaction and other areas where we don't do projects?

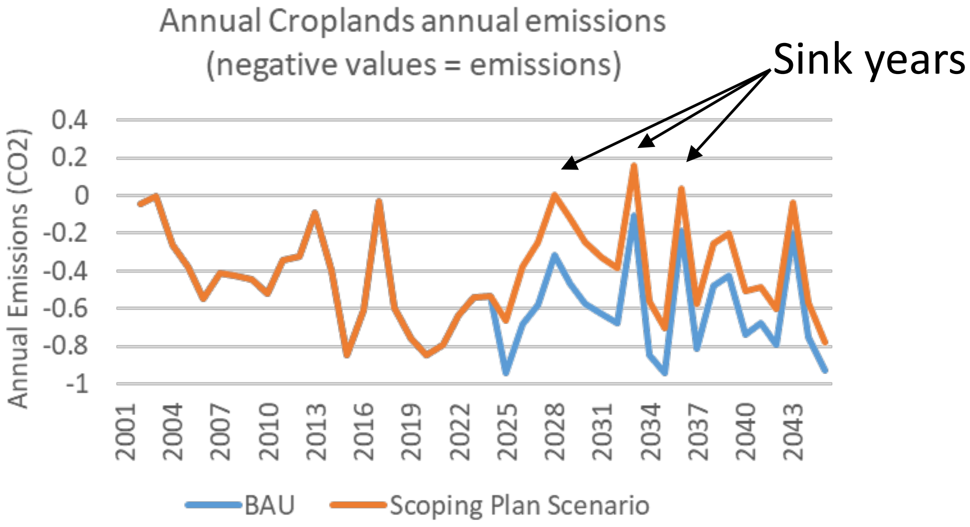


Statewide accounting (the entire carbon balance of the state)

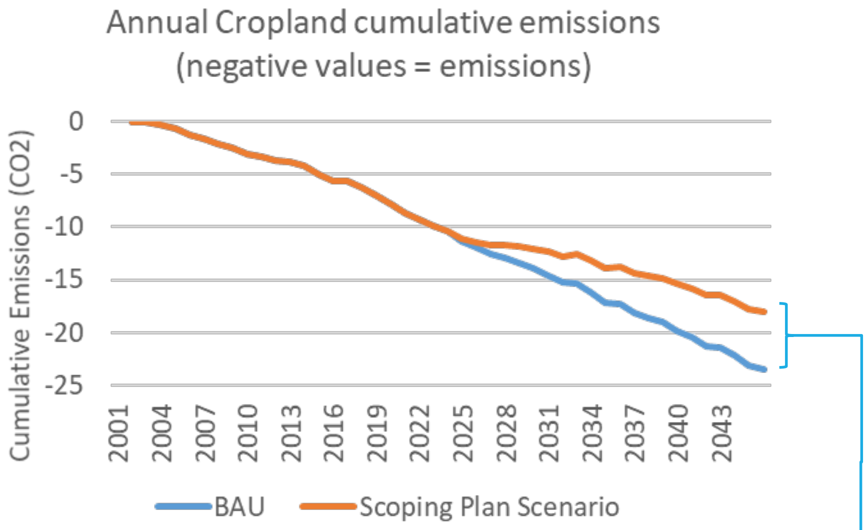
NWL may or may not be a sink from year to year

Objectives of NWL Modeling (2)

- Assess ecosystems through time



NWL are very variable from year to year



Cumulative reduction in overall emissions as a result of action

Objectives of NWL Modeling (3)

- Quantify the impact of climate change and other major drivers of ecosystem change
  - E.g., wildfire, drought, land use change, etc.
- Simulate effect management can have on outcomes
- Create repeatable process that can be built upon
- Ensure that inputs and assumptions are based on science
- Outcomes can be tracked over time in the real world

Photo courtesy of Adam Moreno

Criteria for Choosing a Model

- Open source or at least publicly accessible
- Dynamic Fire (where applicable)
- Coupled dynamic carbon and water (ideally hydrology)
- Dynamic vegetation mortality
- Scalable
- Ecosystem types that can be modeled
- Existing user-base
- Maturity

Photo courtesy of Adam Moreno

CARB Scoping Plan NWL Models

NWL Sub-Category	Model
Forests	RHESSys
Shrublands	RHESSys
Grasslands & Rangelands	RHESSys
Sacramento-San Joaquin Delta	SUBCALC/Literature
Urban Forests	CARB Urban Forest Carbon Model
Wildland Urban Interface	California Forest Observatory/CARB NWL Inventory
Annual Croplands	Daycent/LUCAS/Literature
Perennial Croplands	CARB Orchard Carbon Model/LUCAS
Deserts	CARB NWL Inventory/LUCAS


Photo courtesy of Adam Moreno

NWL Modeling Approach – Forests, Shrublands, Grasslands

Model: Regional Hydrological and Ecological Simulation System (RHESSys)

Algorithm: Biogeochemical model with climate change, dynamic fire, mortality, and hydrology

Method: Representative watersheds used to extrapolate statewide

Treatment categories assessed:

- Clearcut, Harvest, Thinning, Mastication, Mechanical, Bio/Chem/Herb, Prescribed Fire

Different ownership/regional combinations manage differently

- Federal, Tribal, State, County, City, Special District, NGO, Forest Industry, Other Private

Riparian zones included


Photo courtesy of Adam Moreno

NWL Modeling Approach – Agriculture

Annual Agriculture

Model: DayCent

Algorithm: Biogeochemical with climate change and management impacts

Method: Based on national inventory methods, and utilizes previous research from the development of Comet-Planner

Perennial Agriculture

Model: CARB Orchard Carbon Model

Algorithm: Allometric based utilizing the NWL inventory methods survey data

Method: Aspatial planting and push rates based on past practices and adjusted with climate and land use projections

Rangelands covered in shrublands and grasslands

NWL Modeling Approach – Settlements

<u>Urban Forests</u>

Model: CARB Urban Forest Carbon Model

Algorithm: Empirically based

Method: Statewide aspatial carbon driven by climate, investment, and water use change

<u>Wildland Urban Interface</u>

Model: WUI Defensible Space Compliance Model

Algorithm: Remote sensing based spatially explicit assessment

Method: Quantify carbon removal for 100% defensible space compliance for every building in California

Photo courtesy of Adam Moreno

NWL Modeling Approach – Wetlands

Photo courtesy of Adam Moreno

Delta wetlands

Model: SUBCALC model, Flux towers

Algorithm: Biogeochemical and Eddy covariance modeling

Method: Model and literature values based on flux towers

Change fluxes based on changes in land use, and wetland restoration

NWL Modeling Approach – Deserts

Model: CARB derived model

Algorithm: Land use change focused

Method: Adjusts carbon stocks based on projections of land use change

Photo courtesy of Adam Moreno

Practices Currently Modeled (1)

Forests: biological/chemical/herbaceous treatments (e.g. herbicide application), clear cut, various timber harvests (e.g. variable retention, seed tree/shelterwood, selection harvesting), mastication, other mechanical treatments (e.g. piling of dead material, understory thinning), prescribed burning, and thinning. Wildfire, nutrients, and water are modeled and are responsive to management strategies and climate conditions.

Shrublands/Chaparral: biological/chemical/herbaceous treatments, prescribed burning, mechanical treatment, such as mastication, crushing, mowing, piling, etc. Avoided land conversion. Wildfire, nutrients, and water are modeled and are responsive to management strategies and climate conditions.

Grasslands: biological/chemical/herbaceous treatments, prescribed burning. Avoided land conversion. Wildfire, nutrients, and water are modeled and are responsive to management strategies and climate conditions.

Annual Croplands: Cover cropping, no till, reduced till, compost amendment, transition to organic farming, avoided conversion of annual crop ag land through easements, establishing riparian forest buffers, alley cropping, establishing windbreaks/shelterbelts, establishing tree and shrubs in croplands, and establishing hedgerows .

Practices Currently Modeled (2)

Perennial Croplands: Windbreaks/shelterbelts, hedgerows, conversion from annual crops to perennial crops, and avoided conversion to other land - uses. Change planting and pushing rates.

Settlements: Increasing funding for urban forestry and improve water use; and removing vegetation surrounding structures in accordance with the CALFIRE Defensible Space PRC 4291.

Delta Wetlands: Restoring wetlands through submerging cultivated land in the Sacramento - San Joaquin Delta and other wetland restoration. Avoided land conversion in the Sacramento - San Joaquin Delta.

Sparsely Vegetated Lands: Avoided conversion of sparsely vegetated lands to another land use.

Feedback on Approach (not exhaustive)

- Practices to add:
  - Post-fire reforestation, composting on rangelands, organic agriculture, more nuanced biomass/harvested wood product utilization, stacked practices, grazing, riparian restoration
- Landscapes/pools to add:
  - Coastal wetlands, more blue carbon, more soil carbon, more urban green spaces
- Additional analyses to perform:
  - More fire analyses, more emissions speciation, more health analyses, local level assessments, longer simulations
- Processes improvements:
  - Peer-review of work, more EJ and tribal collaboration, more coordination with sister agencies

Future Modeling Developments (started before AB 1757 was signed)

Within 12 months

- Forests, Shrublands, Grasslands
  - Improved parameterization
  - Uncertainty/error analysis
  - Publish scientific journal article
- Annual agriculture
  - Organic agricultural systems
  - Differing irrigation practices
  - Stacked practices
  - Farm idling
  - More control over timing of implementation
  - More simulations to better represent all agricultural lands
- Coastal wetlands
  - Work with Ocean Protection Council to identify knowledge and data gaps and how to fill them

12+ months

- Forests, Shrublands, Grasslands
  - Wall-to-wall statewide simulations
  - Creation of manual/tutorial for model use
  - Enhancing wildfire air quality impact analysis

Future Modeling Developments (within 12 months, not currently underway)

- Forests, Shrublands, Grasslands
  - More detailed fire and morality assessments
  - Include more management actions (e.g., grazing, composting)
  - More nuanced management implementation
  - More nuanced riparian management

Photo courtesy of Adam Moreno

Future Modeling Developments (12+ months , not currently underway)

Photo courtesy of Adam Moreno

- Forests, Shrublands, Grasslands
  - Attribution study
  - Management practice effectiveness study
  - How upper watershed management impacts water availability for different sectors of the economy
  - Incorporate WUI veg management, home hardening, and energy infrastructure into wildfire modeling
  - Utilize more advanced harvested wood products modeling

Future Modeling Developments (12+ months , not currently underway) (1)

- Perennial Agriculture
  - Utilize biogeochemical model
  - Simulate more healthy soils practices
  - Better account for ground water
- Wetlands
  - Enhance modeling for the Delta
  - Include coastal wetlands
  - Include riparian zones in/around reservoirs, working lands, and communities
  - Include mountain meadows more explicitly
  - Incorporate sea level rise

Photo courtesy of Adam Moreno

Future Modeling Developments (12+ months , not currently underway) (2)

- Urban Forests
  - Incorporate more than trees
  - Make spatially explicit
  - Utilize process-based model
- Deserts
  - Model using biogeochemical model for organic carbon
- Health
  - Expand health modeling to all NWL sectors

Photo courtesy of Adam Moreno

Future Modeling Developments (12+ months , not currently underway) (3)

- Economic analysis
  - Conduct more nuanced impact analysis by income level, geography, and race
  - Assess impacts on prices of wood, water, food, and fiber
  - Assess impact of change to yield and co-benefits on producers and various other sectors of the economy
- Ecosystem services
  - Connect various models together to quantify co-benefits (habitat suitability, biodiversity, water availability to other sectors, yield, recreation access, etc.)
  - Incorporate a valuation of ecosystem services to quantify economic benefits of various co-benefits and how they change with management and climate
- Land cover/Land use
  - Incorporate/develop more dynamic land use model that adapts with changing economics and environmental conditions
  - Incorporate more land use changes between NWL sectors
  - Incorporate Dynamic Global Vegetation Model

Current Limitations to Modeling Development

- Empirical data on management actions and practices in all sectors
- Spatiotemporal empirical data on soil organic carbon stocks and fluxes
- Science and data sufficient for model and inventory development for most sectors
- Sufficient science to develop an emissions-based inventory for NWL
- Cross sectoral model development, integration, and science
- Computing resources
- Qualified ecosystem modelers with sufficient computer programming skills