2023 COASTAL MASTER PLAN

TEST RUNS FOR RECOMMENDED UPDATES (G028-G031)

SUPPLEMENTAL MATERIAL D2.1

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COASTAL PROTECTION AND RESTORATION AUTHORITY

This document was developed in support of the 2023 Coastal Master Plan being prepared by the Coastal Protection and Restoration Authority (CPRA). CPRA was established by the Louisiana Legislature in response to Hurricanes Katrina and Rita through Act 8 of the First Extraordinary Session of 2005. Act 8 of the First Extraordinary Session of 2005 expanded the membership, duties, and responsibilities of CPRA and charged the new authority to develop and implement a comprehensive coastal protection plan, consisting of a master plan (revised every six years) and annual plans. CPRA's mandate is to develop, implement, and enforce a comprehensive coastal protection and restoration master plan.

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LIST OF ABBREVIATIONS

CPRA .... COASTAL PROTECTION AND RESTORATION AUTHORITY

CRMS .... COASTWIDE REFERENCE MONITORING SYSTEM

FFIBS ....FRESH, FORESTED, INTERMEDIATE, BRACKISH, SALINE

FIBS ....FRESH, INTERMEDIATE, BRACKISH, SALINE

FWOA ....FUTURE WITHOUT ACTION

ICM ....INTEGRATED COMPARTMENT MODEL

OMAR ....ORGANIC MATTER ACCUMULATION RATES

1.0 TEST RUNS G028 AND G029

1.1 DESCRIPTION OF RUNS AND HYPOTHESES

Model tests were undertaken to assess recommended updates to Integrated Compartment Model (ICM)-LAVegMod, including the addition of new species, the application of a weighted averaged value for fresh, intermediate, brackish, saline (FIBS) habitat type classification, the addition of bareground (without lowering of old bareground), the addition of a 2-week salinity mortality, updates to flotant and forested wetlands, and updates to dispersal rules. G028 included these recommended updates except for the new dispersal rules; G029 included updates from G028 plus the new dispersal rules.

There are several key differences from the approach for these test runs compared to previous model runs. Both test runs used ICM-Hydro and ICM-Morph outputs from 2017 Coastal Master Plan run S03G300. Thus, changes in land area over time were not responsive to the ICM-LAVegMod updates being tested, and because of this, the focus for evaluation was on land cover types and distributions. ICM-Hydro and ICM-Morph outputs from S03G300 were selected in order to best evaluate how modified dispersal rules changed the extent of bareground. The 2017 high environmental scenario (S03) produced rapidly changing conditions leading to bareground, especially in later decades without updates to the dispersal rules, and in G300 these effects were not mitigated by master plan projects. However, as S03G300 did not include sediment diversion projects, there were no locations where new deltaic areas were developing in areas not already experiencing deltaic conditions.

Prior to test runs G028 and G029, the following effects were hypothesized for the test runs, and the results were examined for such effects:

- Similar results to G025 (smoother transitions between habitat types) for areas not influenced by projects;
- More bareground fresh areas in years following 2 week salinity threshold exceedance;
- Salinity-induced bareground in areas where acute mortality is triggered (fresh marshes) followed by some recovery (e.g., Year 34-35 northwest of Houma in ICM compartment 347 and Year 41-42 for the Lake Verret Basin in ICM compartment 393);
- Greater loss of *Eleocharis* flotant vs. *Panicum* flotant;
- Forested wetlands transition to fresh and intermediate marshes;
- For G029, vegetation establishment on most available bareground (except in brackish areas), so less bareground than for G028, and species in high dispersal class dominant in deltaic areas with new land.

1.2 RESULTS

The examination of changes in distribution of habitat types is based on comparison of G028 and G029 to each other and of the results of both test runs to G300 from the 2017 Coastal Master Plan.

1.3 DISPERSAL

Changes in the dispersal rate lead to less bareground, especially in the Upper Barataria Basin. The addition of the high dispersal species for G029 does not lead to large changes in marsh type distribution compared to G028 (Figure 1).

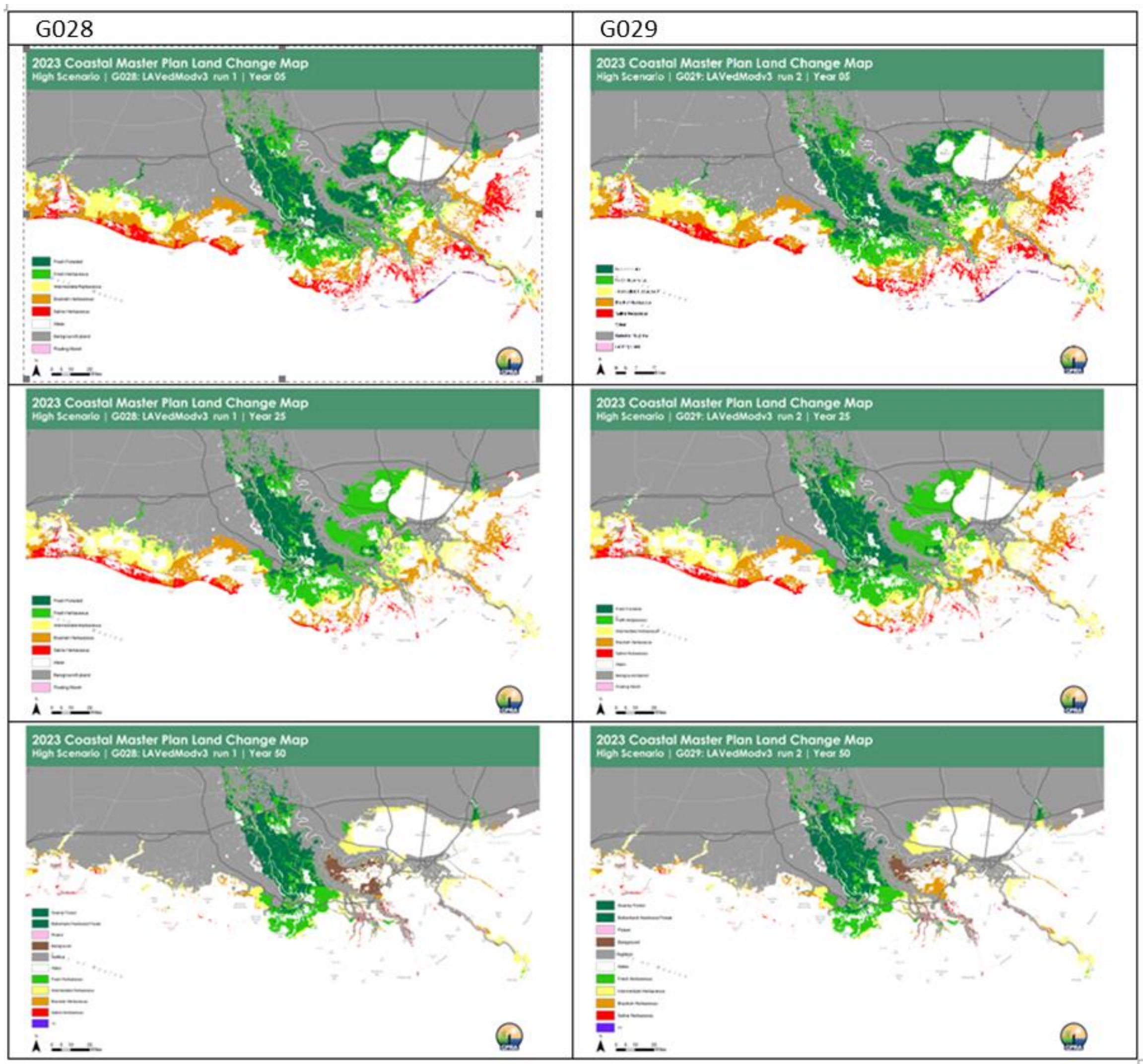


Figure 1. Land Change Maps for G028 (left) and G029 (right) at Years 5 (top), 25 (middle), and 50 (bottom).

Figure 2 shows habitat coverage over time for the Barataria Basin ecoregion show no significant changes in marsh types with or without updates to dispersal and confirm a reduction in bareground with dispersal (G029) in the Upper Barataria Basin.

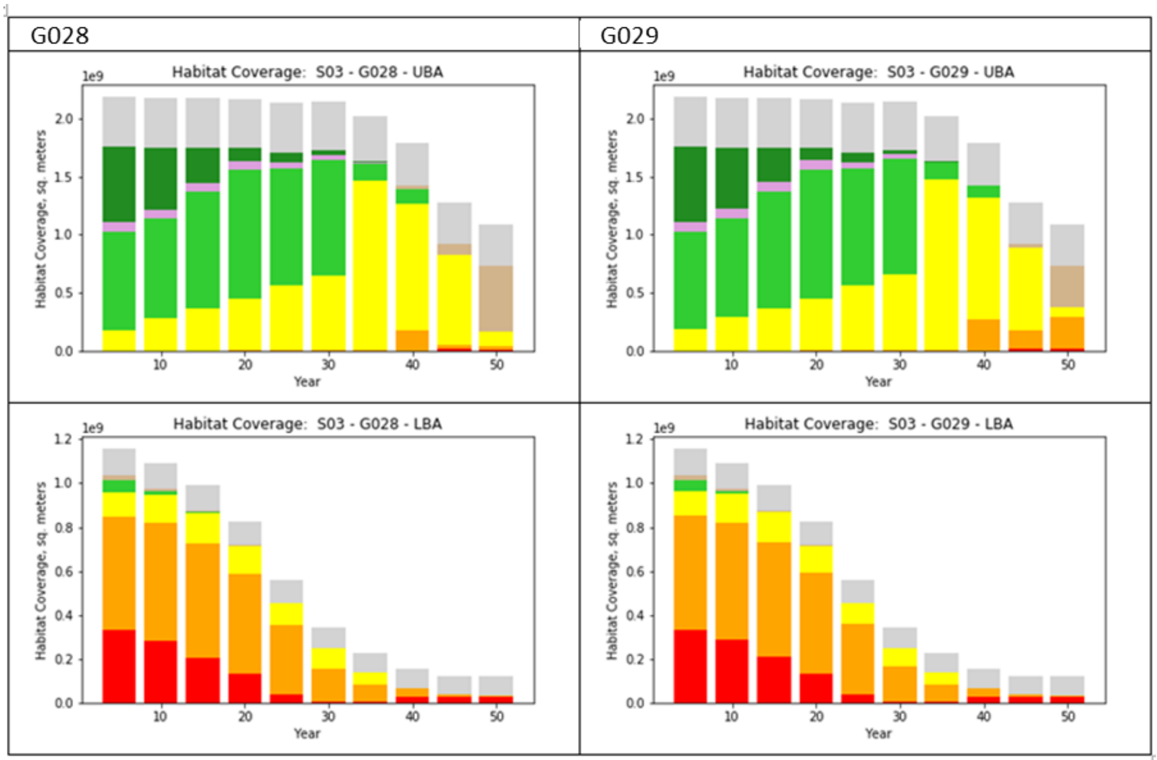


Figure 2. Change in Habitat Coverage over time for G028 (left) and G029 (right) in Upper Barataria, or UBA (top) and Lower Barataria, or LBA (bottom).

Figure 3 shows a representative cell in an area that is bareground in G028 and brackish in G029 at Year 50. With one-cell only dispersal (G028), bareground is created in Year 47 with vegetation re-establishing in Year 48. Bareground then occurs again in Year 49 with no re-establishment. With the increased dispersal (G029), *Distichlis* (DISP), which can now move in from one or from two cells away, colonizes the area.

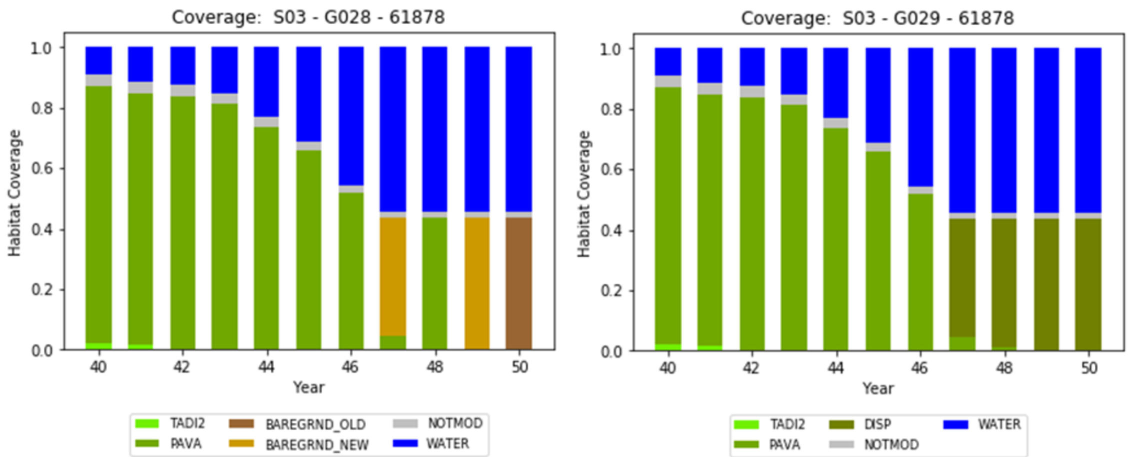


Figure 3. Change in Habitat Coverage over time for G028 (left) and G029 (right) for a representative cell in the area east of Lac Des Allemands (61878).

1.4 SCORING APPROACH

Using the FIBS (fresh, forested, intermediate, brackish, saline) score to assign habitat types with updated species in the model shows more intermediate marsh and less fresh marsh as well as more brackish marsh and less saline marsh compared to results of G300 from the 2017 Coastal Master Plan. Examination of the results from G028 for Year 25 show a much greater extent of intermediate marsh, notably in the Chenier Plain and in the Upper Barataria Basin, with more gradual transitions between fresh and brackish/saline marshes as found for G025 (Baustian et al., 2020). An example of a smoother transition can be seen east of White Lake where in G300 fresh marsh (green) and saline marsh (red) are directly juxtaposed. In G028 there was a transition from intermediate to brackish marsh with saline marsh more restricted in area (Figure 4).

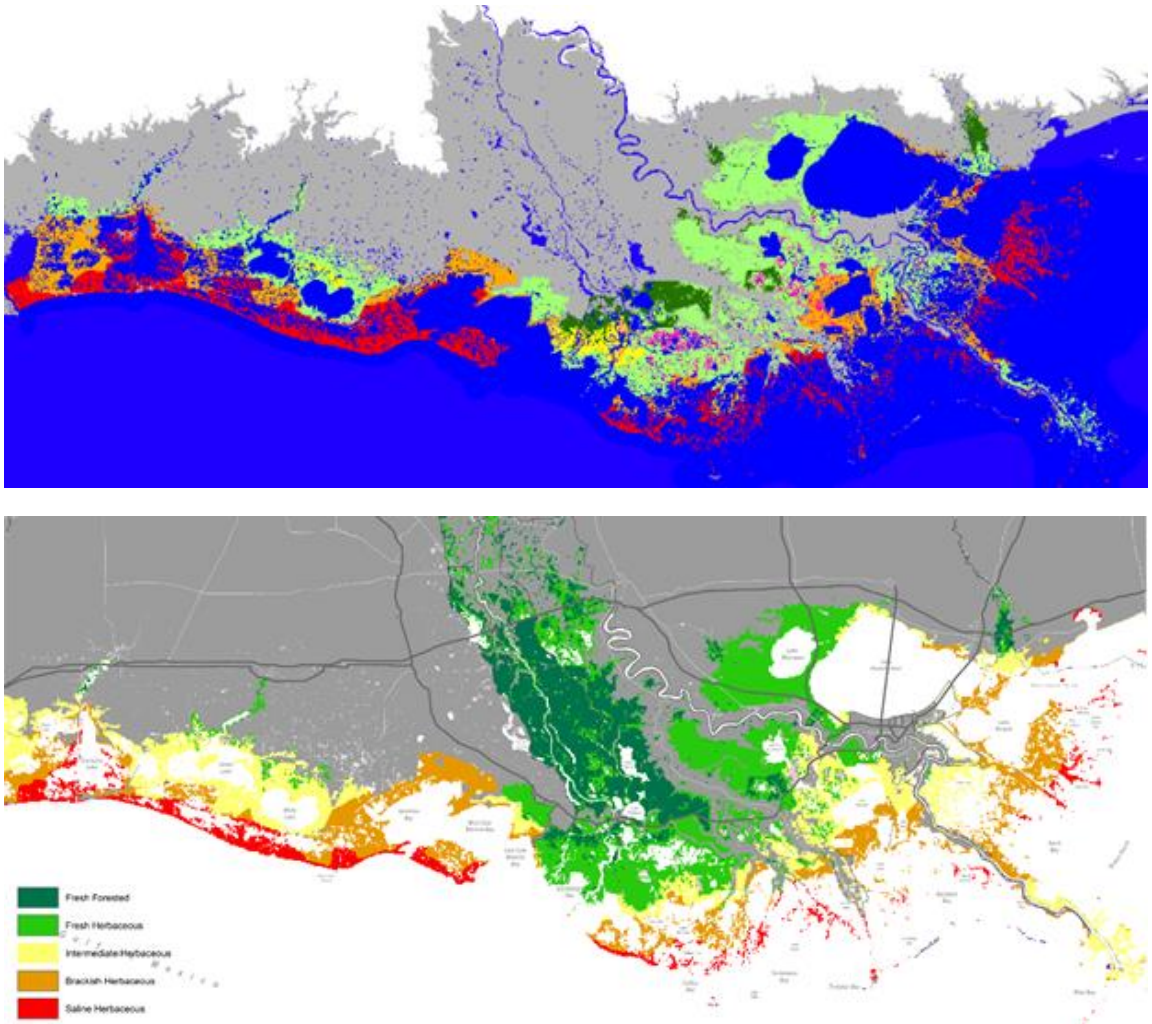


Figure 4. Vegetation coverage at Year 25 for G300, S03 (top) and for G028, S03 (bottom).

However, the weighted classification used did not include a category for forested wetlands for these test runs. A modified set of FFIBS scores (fresh, forested, intermediate, brackish, saline) that distinguish areas of forested wetlands (swamp + bottomland hardwood) from fresh marsh (Table 1) and a new table for distinguishing the score into FFIBS classes (Table 2) were developed for future runs.

Table 1. Habitat types, species, and FFIBS scores

Habitat	**Species**	**FFIBS Score**
Bottomland Hardwood Forest	*Quercus lyrata, Quercus texana, Quercus laurifolia, Ulmus americana, Quercus nigra, Quercus virginiana*	0
Swamp Forest	*Salix nigra, Taxodium distichum, Nyssa aquatica*	0
Fresh Floating Marsh	*Panicum hemitomon, Eleocharis baldwinii*	0.25
Fresh Attached Marsh	*Morella cerifera, Panicum hemitomon, Sagittaria latifolia, Zizaniopsis miliacea, Colocasia esculenta*	0.25
Intermediate Marsh	*Cladium mariscus, Sagittaria lancifolia, Polygonum punctatum, Eleocharis cellulosa*	1.50
	Iva frutescens, Paspalum vaginatum, Phragmites australis, Schoenoplectus californicus, Typha domingensis,	2.75
Brackish Marsh	*Spartina patens, Schoenoplectus americanus,*	7.15
	Spartina cynusuroides, Schoenoplectus robustus	11.50
Saline Marsh	*Juncus roemerianus, Distichlis spicata,*	17.50
	Spartina alterniflora, Avicennia germinans	24.00

Table 2. FFIBS class and weighted averaged FFIBS scores

FFIBS Class	Weighted Averaged FFIBS Score
Forested wetland	≤ 0.15
Fresh	0.15 < x ≤ 1.5
Intermediate	1.5 < x ≤ 5
Brackish	5 < x ≤ 18
Saline	>18

1.5 FLOATING MARSH

Examination of output for Year 45 for the Barataria Basin shows flotant marsh (pink), which consists of fresh species, surrounded by brackish marsh (orange) for S03G300. The G028 test shows that fresh marsh is no longer present in Year 45 in Upper Barataria, consistent with updates to ICM-LAVegMod including transitions in flotant marsh species depending on the environmental conditions. Also, using the weighted FIBS classification approach results in remaining marshes in Upper Barataria showing up as Intermediate (Figure 5).

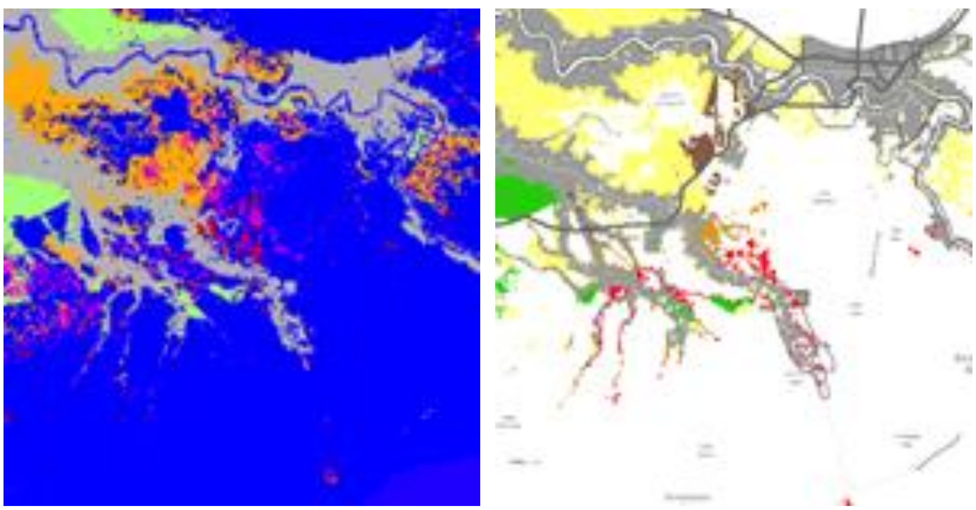


Figure 5. Zoomed in look at vegetation coverage at Year 45 for G300, S03 (left) and for G028, S03 (right) in Barataria Bay.

1.6 BAREGROUND

Figure 6 shows how the distribution of bareground in Year 50 varies among tests and G300 (note the change in coloring – bareground is solid grey in G300 and brown in the test runs). G028 shows more bareground than G300, although some areas of coverage are the same across all three runs (e.g., the northwest corner of the basin). Greater bareground coverage in G028 versus G300 is a result of the mapping approach used. For G028 and G029, cells were mapped as bareground if the sum of bareground (new and old) was greater than half the cell. For G300, cells were mapped as bareground only if zero vegetation remained. G029 shows an increase in brackish coverage for areas that were bareground in G028, which is a result of increased dispersal for some brackish species compared to G300.

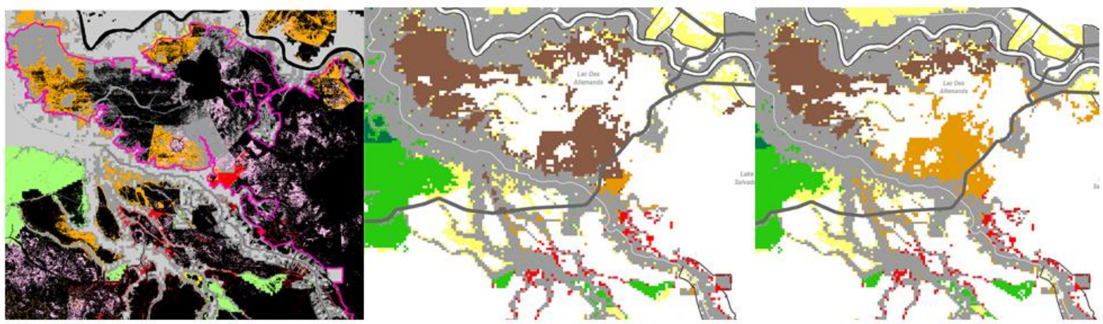


Figure 6. Zoomed-in look at vegetation coverage at Year 50 for G300, S03 (left); G028, S03 (center); and G029, SO3 (right) in Upper Barataria Bay.

In the G300 run, some areas northwest of Houma showed pulsed increases in salinity which exceeded the two week salinity threshold in G300 (Figure 7). This area of the coast was examined to evaluate the new acute mortality threshold (applied to fresh marshes to produce bareground) in Years 34-35 (Figure 7).

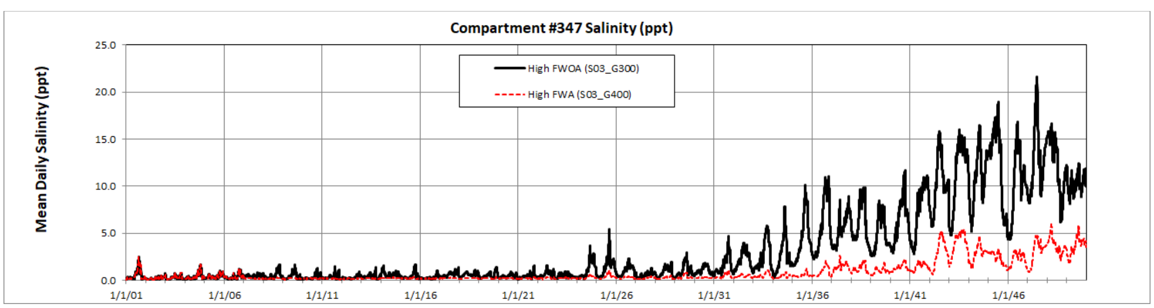


Figure 7. Mean Daily Salinity for Compartment 347, which exceeded the 2 week salinity threshold in G300.

Figure 8 shows the species coverage for a vegetation cell in ICM-Hydro compartment 342. The new species assignments give a different distribution of marsh types than the 2017 model. In G028, there is a gradual increase in intermediate species (darker greens), including those with higher FIBS scores as the salinity increases. Thus, areas subject to a 2 week salinity threshold for fresh marshes in G300 may no longer be considered fresh marsh and thus not subject to the acute salinity mortality with the model updates.

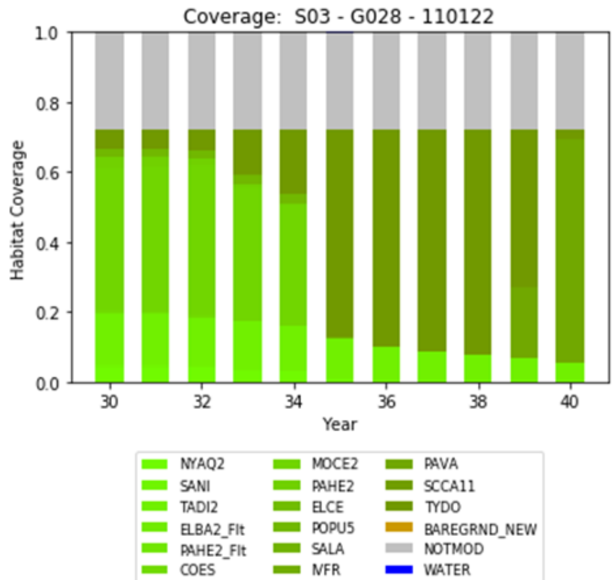


Figure 8. Vegetation Coverage over time for grid cell 110122.

To test the modification to ICM-LAVegMod, it was necessary to find an ICM-Hydro compartment where the two week salinity threshold was crossed that also was classified as fresh marsh in the updated model. Compartment 416 (Figure 9) was selected for Years 38-47. In particular, Year 41 shows a higher salinity peak that Year 40 or Year 42.

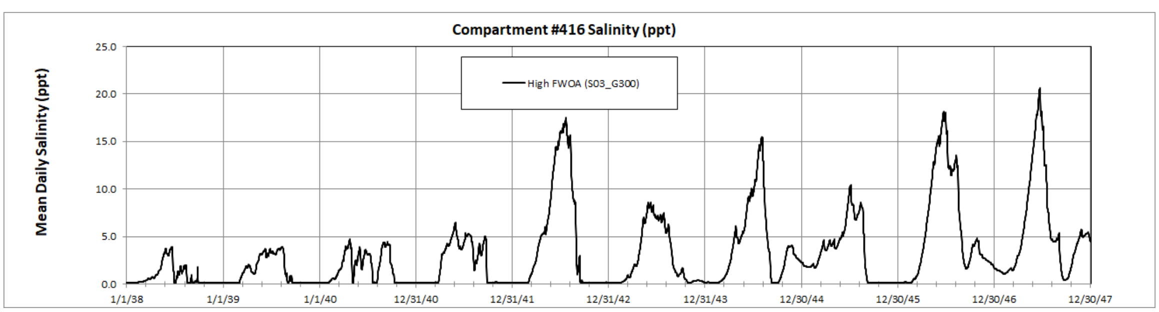


Figure 9. Mean Daily Salinity for Compartment 416 in G300.

Figure 10 shows the species distribution for one vegetation cell in ICM-Hydro compartment 416. In Year 40 the cell is dominated by fresh marsh species (light green), and when the acute salinity threshold is exceeded in Year 41 new bareground results. The conditions that year also lead to an increase in intermediate marsh (darker green on the bar chart). Note that in ICM-LAVegMod, areas which become bareground due to the acute salinity threshold are not eligible for vegetation establishment the year the acute salinity occurs. In the year following the acute salinity conditions, intermediate species establish on the bareground area. There is no difference between G028 and G029 as the species for establishment are readily available in the area.

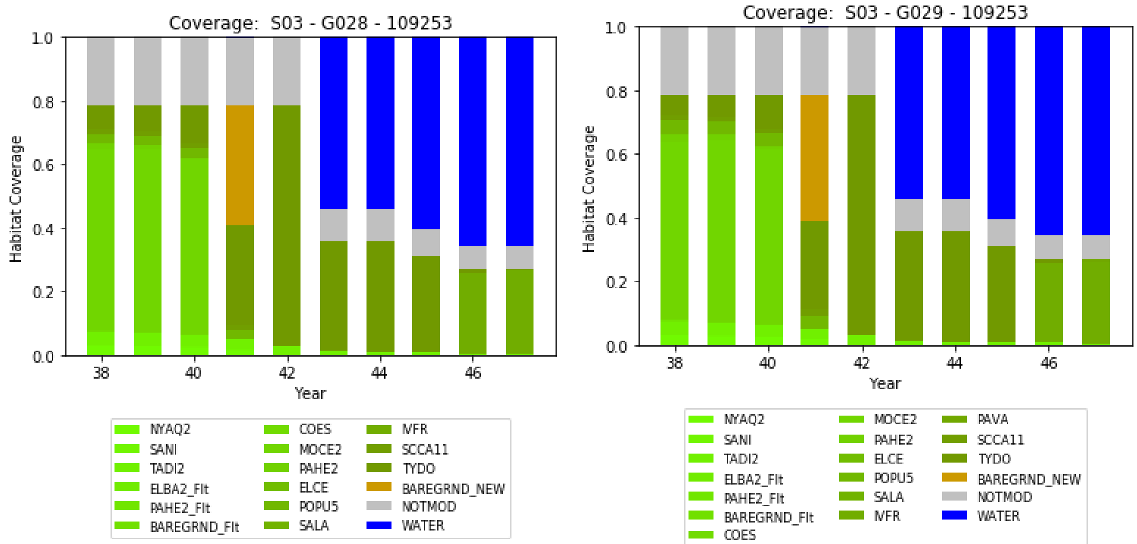


Figure 10. Vegetation Coverage over time for grid cell 109253 for G028 (left) and G029 (right).

1.7 SPECIES-LEVEL RESULTS

MANGROVES, *AVICENNIA* (AVGE)

With the updated dispersal approach applied for G029, there is slightly more mangrove in the later years compared to G028 (Figure 11). Occurrence of mangroves in the Chenier Plain is an artifact of the ICM-Hydro compartment alignment in the 2017 ICM. This causes the Chenier rim to have Gulf of Mexico salinity. Even though mangroves are available for establishment at any location, they can only invade bareground areas with the correct salinity. Other than the Chenier Plain, they are shown primarily around the edges of Timbalier and Terrebonne Bays, where they are currently the most common.

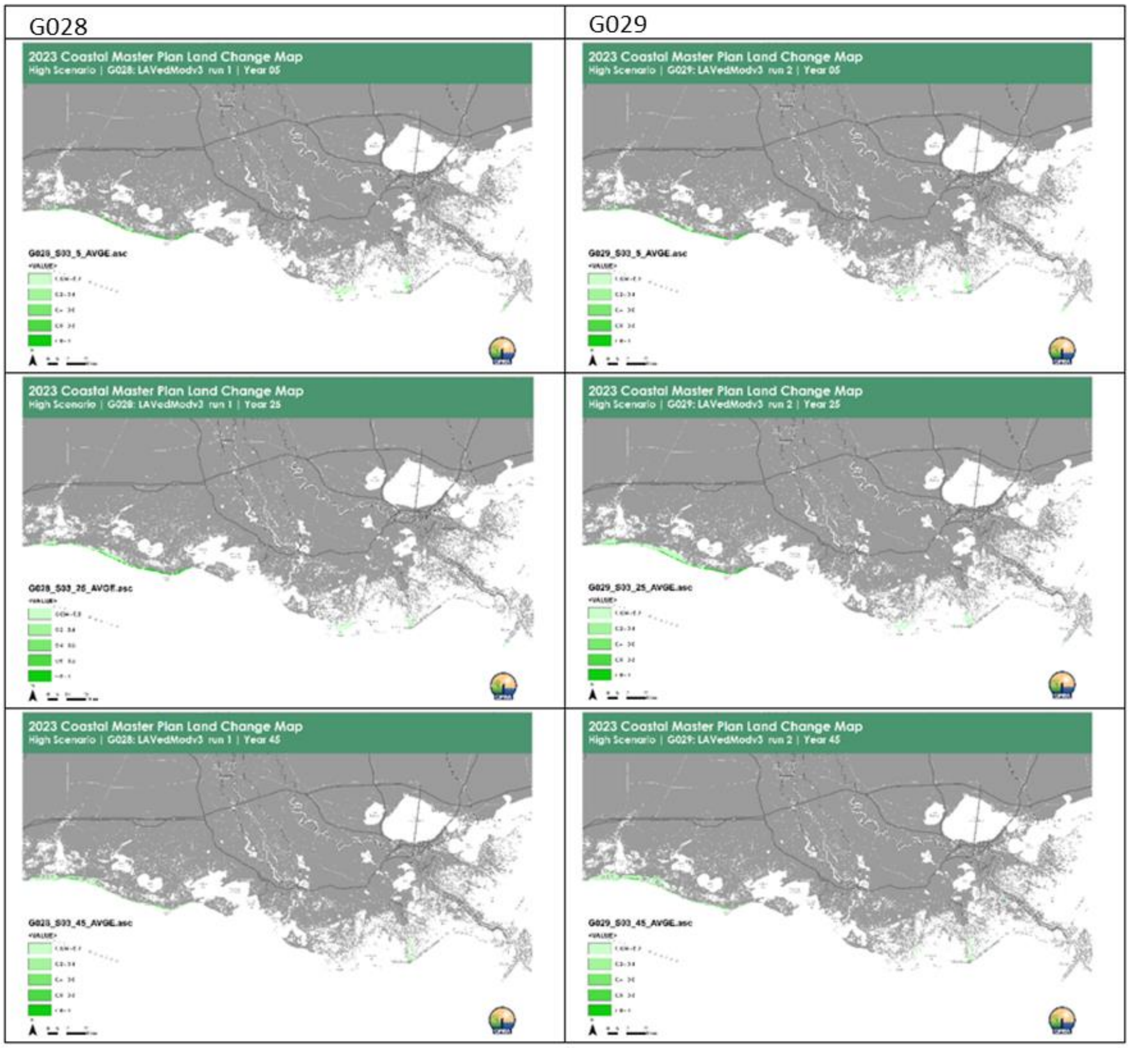


Figure 11. AVGE (*Avicennia*) coverage map for G028 (left) and G029 (right) for Years 5 (top), 25 (middle), and 45 (bottom).

Mangrove was not widely represented in the 2017 vegetation outputs, although it occurred in the initial conditions map. In 2017 outputs, ICM-LAVegMod switched to other species in the early years of the simulations as conditions changed. In later years, when salinity was increasing and more suitable for Avicennia, there was none available to disperse into areas where it potentially could have established due to environmental conditions. G029 includes Avicennia as a species which can disperse widely, wherever conditions are suitable.

Figure 12 shows the initial condition for one of the cells at the coast in the Chenier Plain where Avicennia are observed for G028. The species are mostly intermediate and some bareground is available. The bottom right shows how the species distribution changes in the early years of the simulation with Avicennia becoming dominant. As the cell is right on the coast, it is subject to high salinities in the 2017 ICM (suitable for Avicennia but not the other species), and the new dispersal rules enable Avicennia establishment.

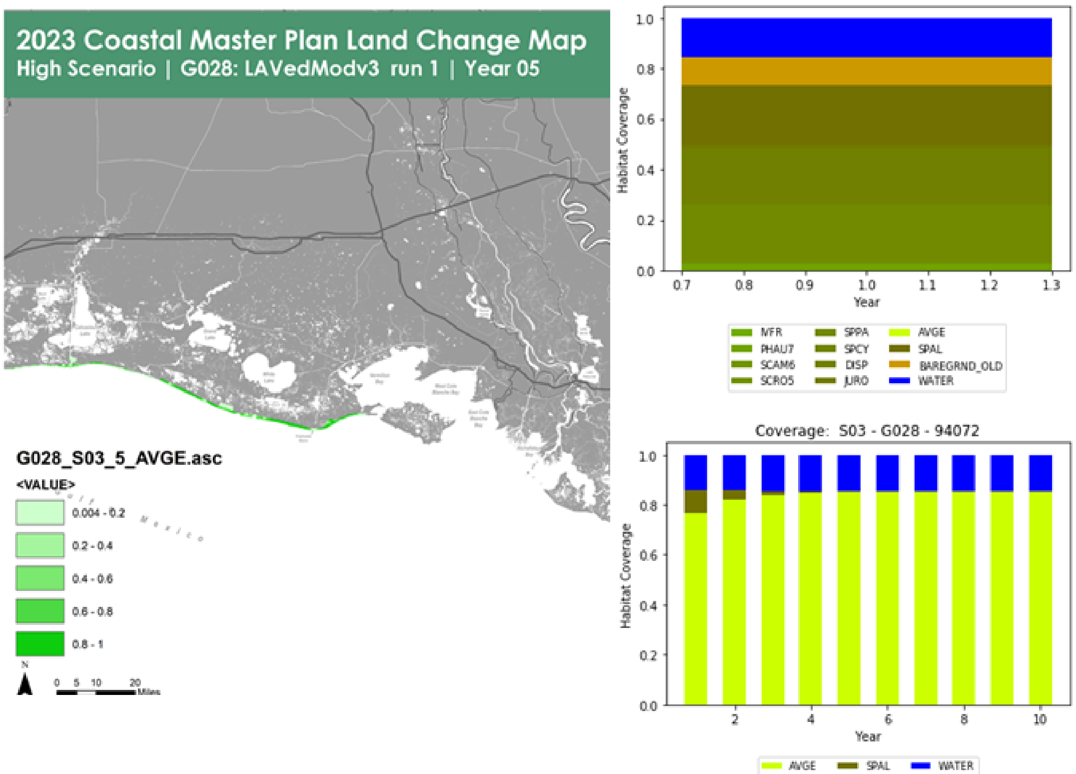


Figure 12. AVGE (*Avicennia*) coverage map for G028 at Year 5 (left); Habitat coverage for initial conditions (top right) and first 10 years of simulation (bottom right) for grid cell 94072.

Such a rapid switch in conditions between those reflect in the initial condition map and the simulation is less likely to occur in the 2023 ICM for several reasons:

- Initial Conditions in the G028 analysis was based on a new map (updated for the 2023 ICM) rather than the map used for the original G300 run, so it may not represent the early years of G300 hydrology used to drive G028.
- A 2 year spin-up period will be included at the start of 2023 ICM production runs to allow species-level mapping to adjust from Existing Conditions to Initial Conditions that reflect model-simulated hydrology.
- Modifications to the ICM-Hydro compartments in the 2023 ICM will improve the

representation of salinity gradients close to the coastal boundary in the Chenier Plain.

ELEPHANT'S EAR, *COLOCASIA ESCULENTA* (COES)

Elephant's ear does not show any changes in distribution between G028 and G029, even though it can move two cells per year in G029 and only one cell per year in G028. It is shown as a rare understory species in forested and fresh wetlands (less than 1% of cover), while it dominates in deltaic wetlands (e.g., Atchafalaya, Wax, and Bird's Foot Deltas). In contrast, Sagittaria latifolia (SALA2) is not present in the initial conditions (it is primarily found under active deltaic conditions, which currently are rare in the landscape), and does not get to establish, because the current version of the code gives priority to species that are already in the vicinity of newly formed land over the high dispersal species (SANI, SALA2, ZIMI, POPU5, TYDO, and AVGE). One way to increase this species will be to give priority to the high dispersal species to establish when land area in a cell expands (see recommendations below).

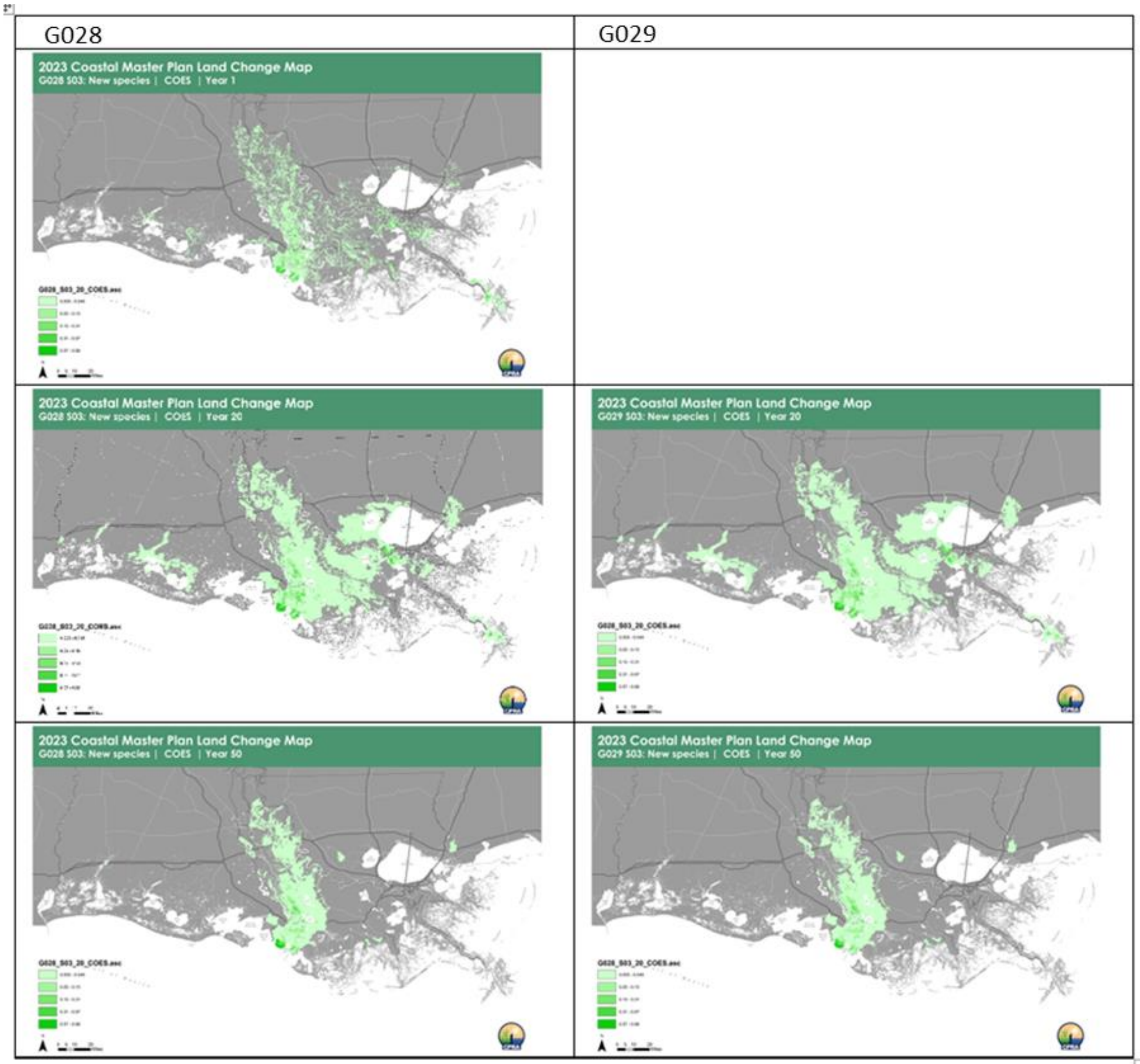


Figure 13. COES (*Colocasia esculenta*) coverages map for G028 (left) and G029 (right) for Years 1 (top), 20 (middle), and 50 (bottom).

ROSEAU CANE, *PHRAGMITES AUSTRALIS* (PHAU7)

Roseau cane shows no differences between the two runs, even though in G029 this is one of the weedy (or high dispersal) species. It is strange that this species is not shown more in the Chenier Plain, where it currently occurs in large areas especially south of Highway 82. However, it seems that this area is more saline in the model (habitat maps) and this may have led to the disappearance of Roseau cane from the area.

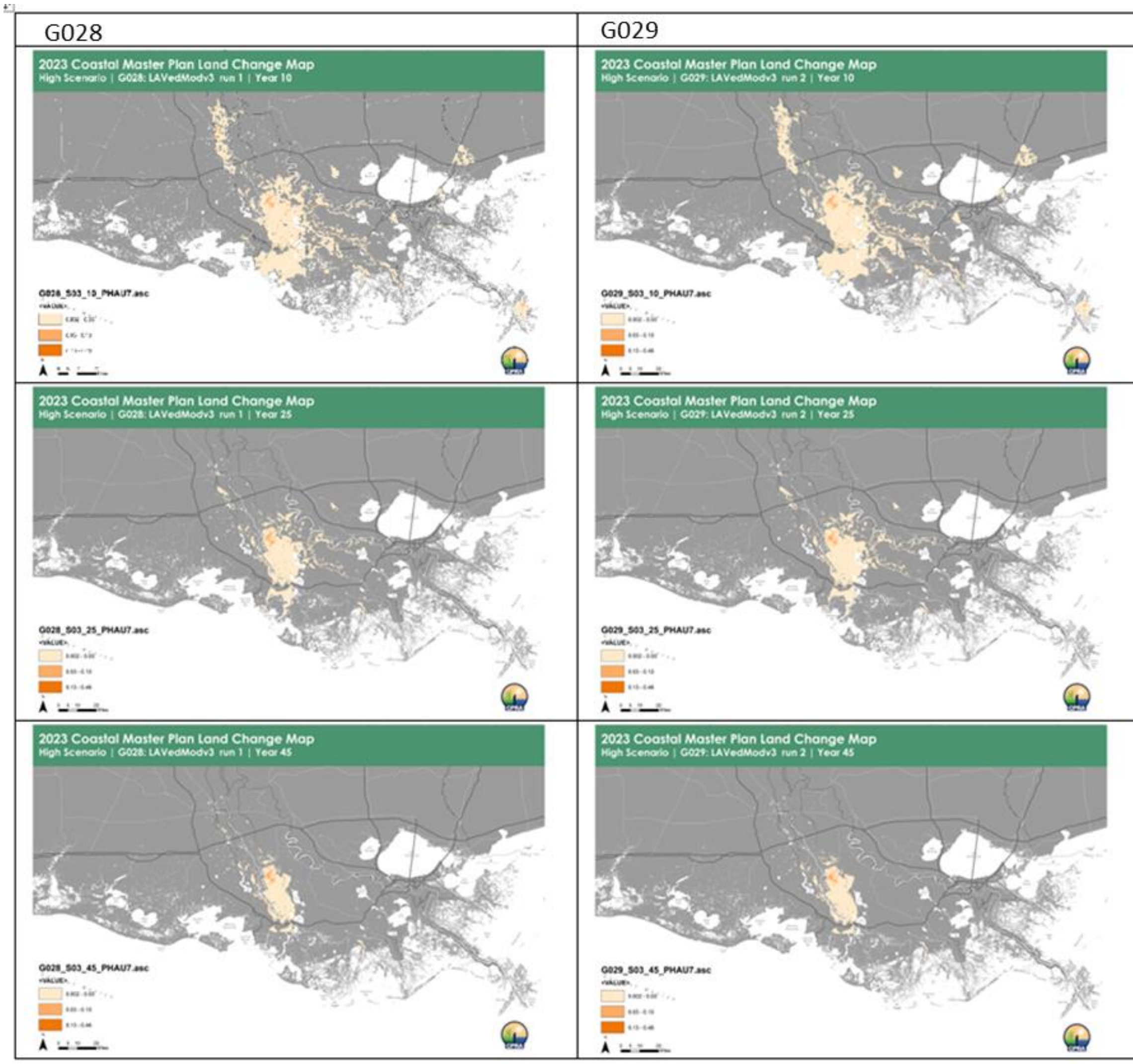


Figure 14. PHAU7 (*Phragmites australis*) coverages map for G028 (left) and G029 (right) for Years 1 (top), 20 (middle), and 50 (bottom).

OLNEY'S THREE-SQUARE, *SCHOENOPLECTUS AMERICANUS* (SCAM6)

Olney's three-square is one of the species that differs in distribution between G028 and G029. With G029 it is more widespread in several areas in Year 50 (NE of White Lake, NW Terrebonne, and Upper Breton). Illustrating that the dispersal rates make a difference, especially in the periods where conditions become extreme.

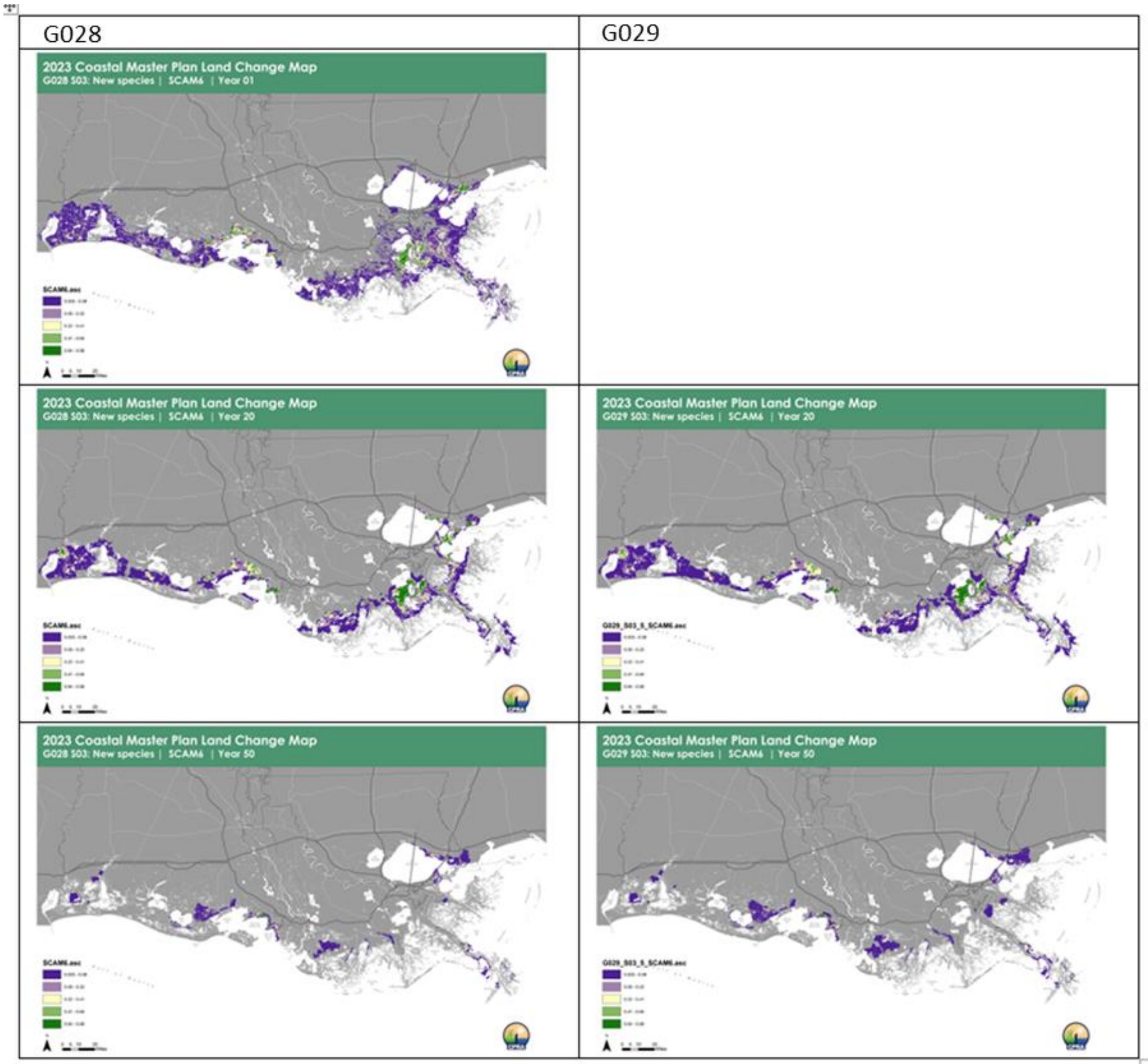


Figure 15. SCAM6 (Schoenoplectus americanus) coverages map for G028 (left) and G029 (right) for Years 1 (top), 20 (middle), and 50 (bottom).

FLOTANT

To examine the changes in flotant marsh we examined four ecoregion points located in areas with extensive floating marshes.

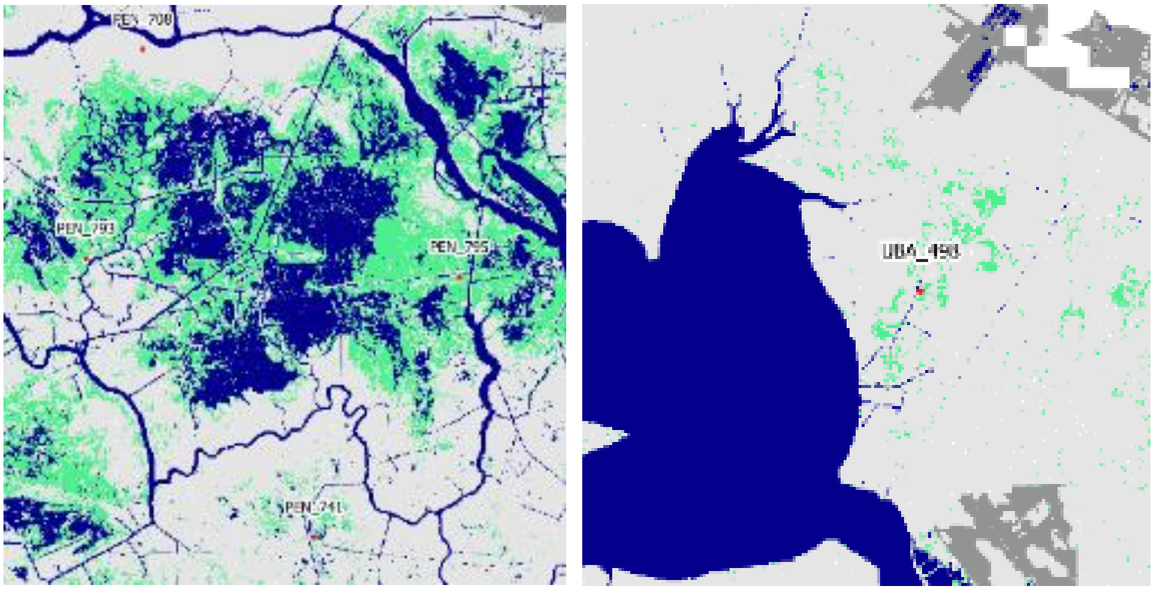


Figure 16. Flotant marsh coverage map at PEN_795, PEN-793, and PEN-741 (left) and at UBA_498 (right).

The first point examined was PEN_795 (VEGMOD 133260), located just west of Bayou Copesaw in Terrebonne Parish in an area dominated by thin-mat flotant (ELBA2). As illustrated by the figure below, maidencane thick mat flotant (PAHE2_FLT) slowly converts to thin-mat (ELBA2_FLT). In contrast, attached maidencane (PAHE2) expands. Wax myrtle (MOCE2) also expands and replaces forested wetlands and intermediate marsh species (TYDO, SALA). An event in Year 42 converts most of the fresh and floating marsh to open water, which are then replaced with intermediate marsh species in Year 43, which should not be possible as the water should be too deep. This issue should be examined and addressed for future runs.

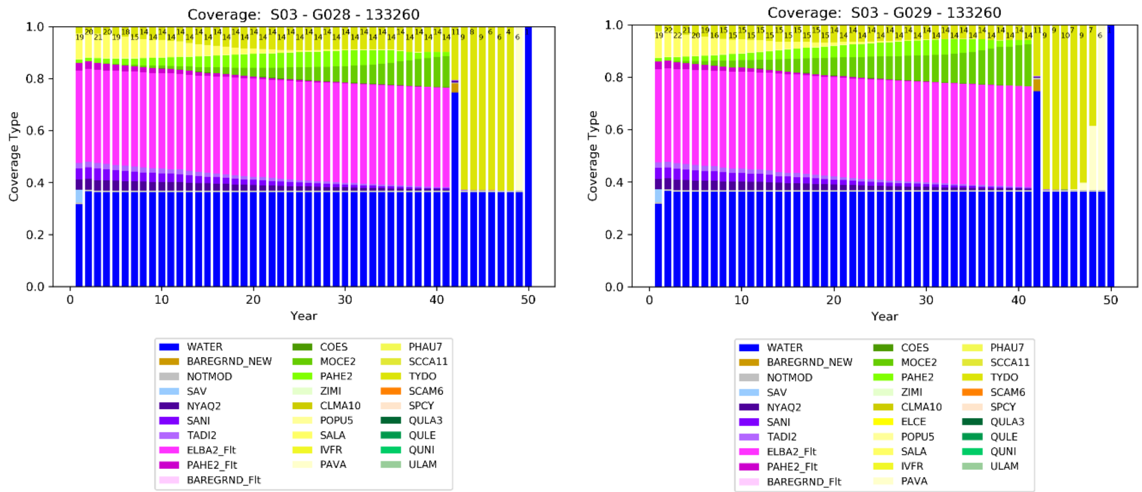


Figure 17. Vegetation coverage for G028 (left) and G029 (right) for grid cell 133260.

The second point examined was PEN_793 (VEGMOD 132526), located just west of Turtle Bayou in Terrebonne Parish in an area that receives increasing back flooding of the Atchafalaya River. In this area flotant mostly consist of thin-mat (ELBA2), and the small amount of thick mat (PAHE2_FLT) seems to hang on until Year 42. Trends show stable thin-mat flotant (ELBA2) with an increase in willows (SANI) in the first few years, followed by a slow decline and increasing wax myrtle (MOCE2) and maidencane (PAHE2). Flotant dies in Year 48, and most of the area converts to open water by Year 50.

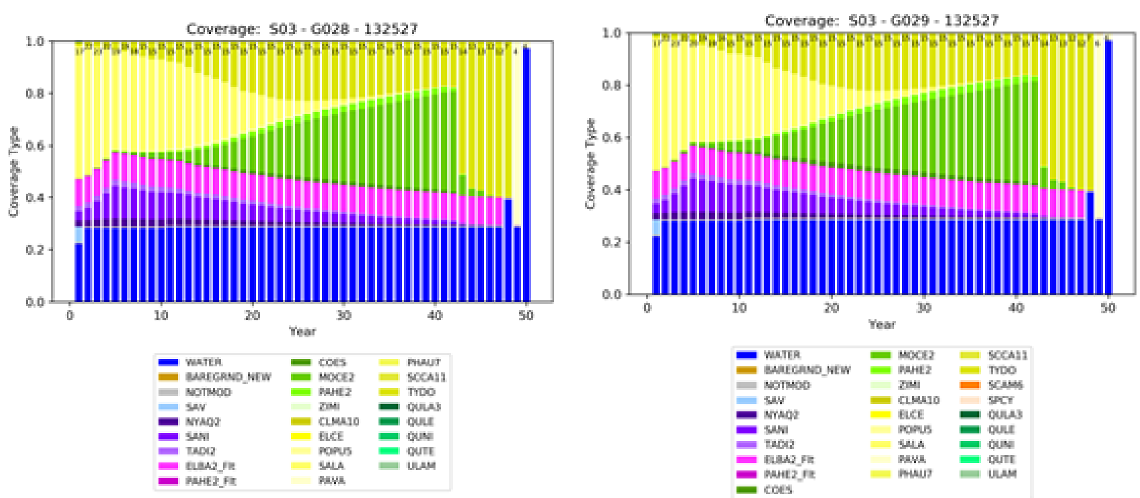


Figure 18. Vegetation coverage for G028 (left) and G029 (right) for grid cell 132527.

The third point examined was PEN_741 (VEGMOD 144437), located south of Bayou Penchant in Terrebonne Parish in an area that is primarily dominated by bulltongue (SALA) and cattail (TYDO). In this area, the small amount of maidencane (both attached or flotant) disappears in the first 10 years. Thin-mat flotant (ELBA2) remains relatively stable except for a small reduction in Year 11, when the same event also leads to loss of attached marsh. Flotant is converted to open water in Year 42.

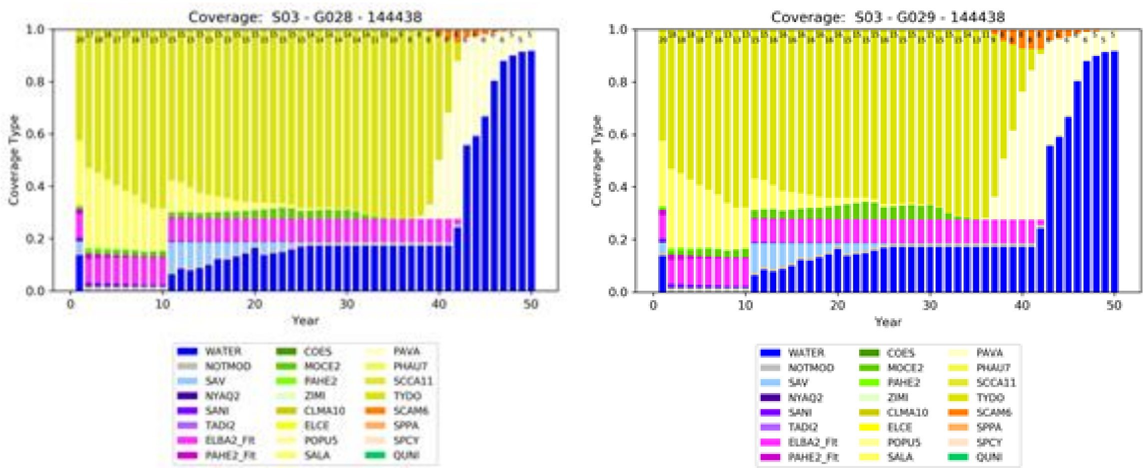


Figure 19. Vegetation coverage for G028 (left) and G029 (right) for grid cell 144438.

The fourth point examined was UBA_498 (VEGMOD 59767), located east of Lac des Allemands. Trends are similar to other points with declining PAHE2 (both floating and attached), and in the later years flotant converts to open water which is then replaced with attached marsh. As discussed previously, this is an issue that should be examined and addressed in future runs since flotant should convert to deep open water that cannot easily re-establish.

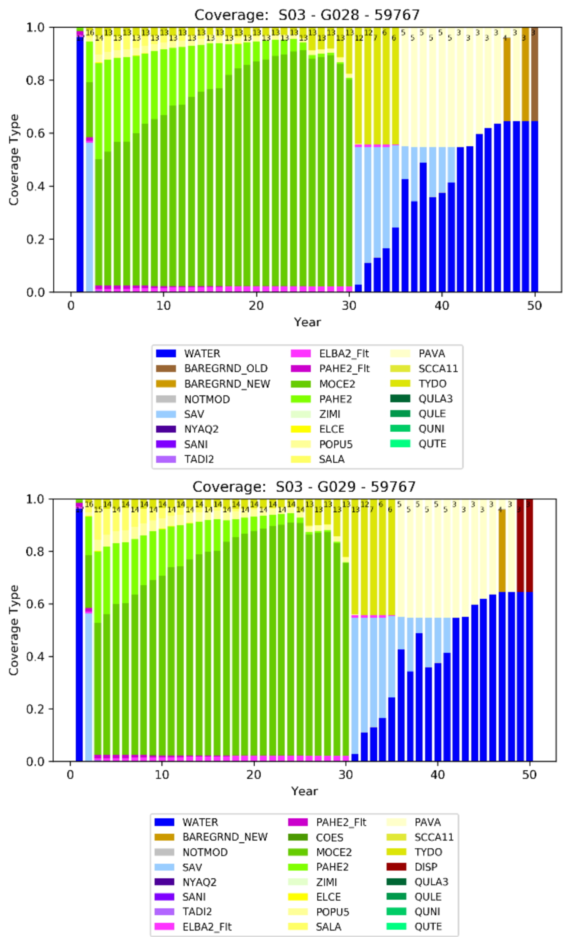


Figure 20. Vegetation coverage for G028 (left) and G029 (right) for grid cell 59767.

1.8 SUMMARY OF FINDINGS

These tests have shown that the improvements in ICM-LAVegMod perform as expected given limitations imposed by using existing 2017 Hydro and Morph outputs for the simulation. Specific results can be summarized in relation to the effects hypothesized in advance. For example, the test runs did show smoother transitions between habitat types (similar results to G025). To further improve representation of fresh forested wetland, an updated scoring table has been developed.

Salinity-induced bareground in areas where acute mortality is triggered (fresh marshes) followed by some recovery (e.g., Year 34-35 near Houma; Year 41-42 in Lake Verret Basin). An area was identified where the acute salinity threshold was crossed in Years 40-42 in an area dominated by fresh marsh. This did result in bareground, which was then subject to establishment by intermediate species the following year.

As flotant is tracked in Morph, only a limited test of changes to flotant was possible for these test runs. However, with the changes flotant loss in the test occurs intuitively in response to changing environmental conditions that alter species distributions.

Forested wetlands transition to fresh and intermediate marshes has been improved, and these transitions will be further enhanced with the new FFIBS score table.

G029 showed increased vegetation establishment on available bareground compared to G028, and this effect was apparent for species in the moderate dispersal class.

The G300 run was not the best base case to evaluate species in high dispersal class dominating in deltaic areas with new land as deltaic areas were already covered in adjacent fresh vegetation and appropriate species were available for dispersal. This change may be better evaluated in a simulation where new deltaic land is built into an open water body where existing fresh marsh is not available as a source for dispersal. In addition, the ICM-LAVegMod code will be changed so that the high dispersal class species are allowed to occupy newly formed land.

RECOMMENDATIONS

- Include updated approach for weighted FFIBS scores that distinguishes forested wetlands (swamp + bottomland hardwood forest) for G030 and G031.
- Adopt the changes in dispersal tested in G029 with an update to allow high dispersal species to establish on emerging land areas first (before senescence).
- Further examine and address the issue of flotant not appearing to convert to deep open water as expected.
- In future runs, continue to track the effects of ICM-LAVegMod changes tested in G029, including:
    - Distinction between Eleocharis flotant vs. Panicum flotant and response to changing conditions.
    - Whether the high dispersal class dominates where new deltaic land is built into open water areas that are not adjacent to existing fresh marsh.
    - The occurrence of mangroves in the Chenier Plain to make sure the results seem feasible and can be explained.

2.0 TEST RUNS G030 AND G031

2.1 DESCRIPTION OF RUNS AND HYPOTHESES

Test run G030 was undertaken to assess updates to ICM-LAVegMod tested in G028 and G029 along with recommended updates in ICM-Morph, including: application of a new organic matter accumulation rate (OMAR) approach (adjusted from the approach tested in G027 – see details below), addition of a rule for accretion to occur in all vegetated areas whether or not they flood in a given year, lowering of bareground_old at 5 cm/yr, and tracking the potential for upland to wetland transitions. A water level variability correction was originally considered for these tests, but was not applied as it was considered unlikely to be needed due to planned ICM-Hydro updates.

Test run G031 was used to assess the interpolation of OMAR values from weighted averaged FFIBS scores. The graphs below show how OMAR values were interpolated across the FFIBS scores for each habitat type. The black line shows values used for G030, and the blue line shows interpolated values (G031). For G031, the lowest FFIBS score for each habitat type is assumed to have the OMAR value assigned to that type (see next section for description of how the OMAR rates were developed) with a linear interpolation to the value assigned for the next type. All saline marsh FFIBS scores use the same saline value for OMAR.

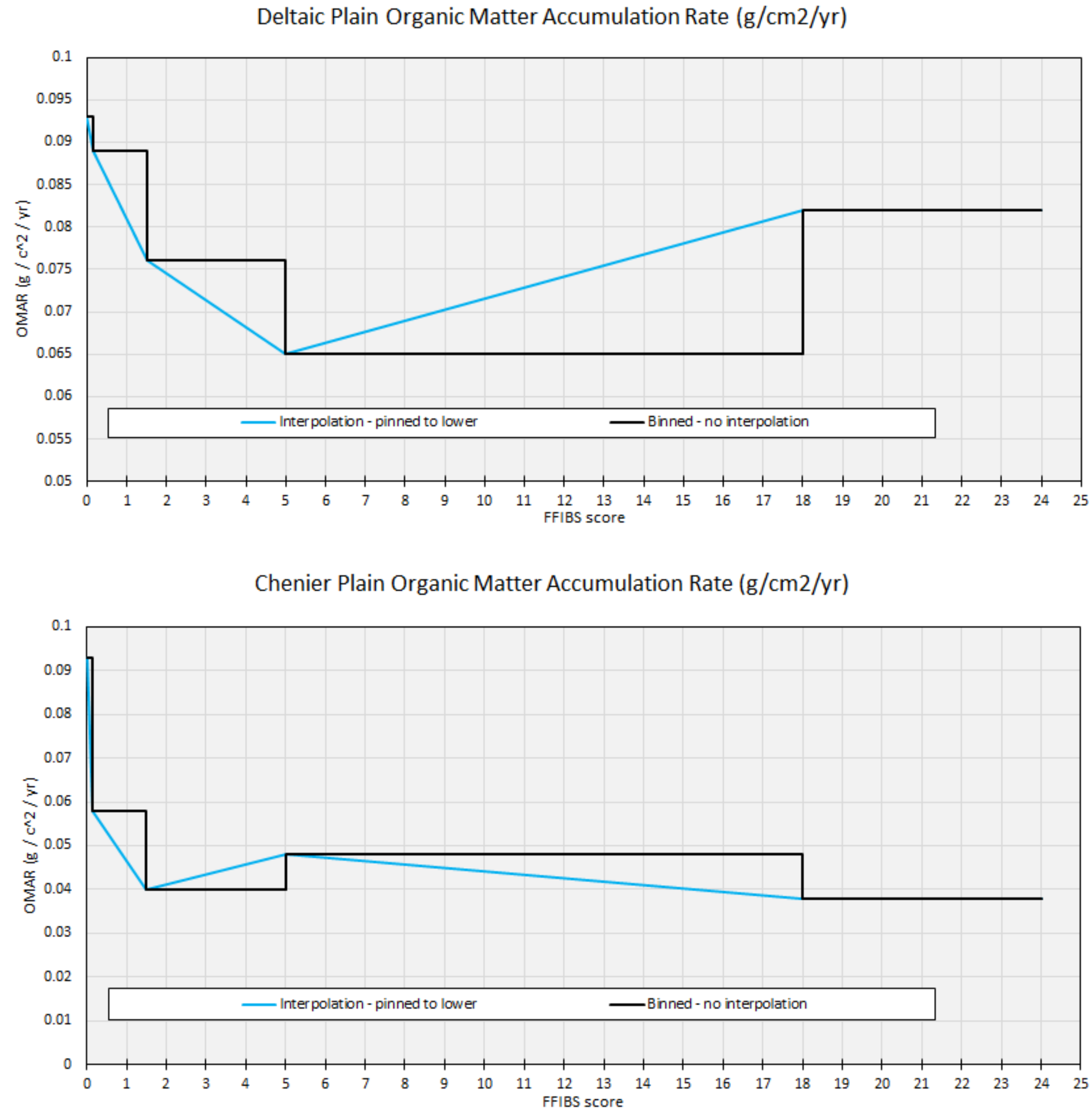


Figure 21. Interpolated Organic Matter Accumulation Rates by FFIBS scores tested for G031. Note that for G031, the wrong value was mistakenly applied for brackish marshes in the Chenier Plain (0.48 instead of 0.42 g/cm^2/yr). The lookup table has been revised so the correct value will be used for future runs.

REVISED LOOKUP TABLES FOR OMAR

Adjustments to the OMAR approach previously tested in G027 for G030 and G031 include determining lookup table values based on the lognormal distributions of OMAR values for Coastwide

Reference Monitoring System (CRMS) sites separated into two regions, the delta plain and the Chenier Plain (Figure 22). Arithmetic means are inappropriate given the skewed distribution of these data (not normal); outliers on the right tail pull the means up a good bit.

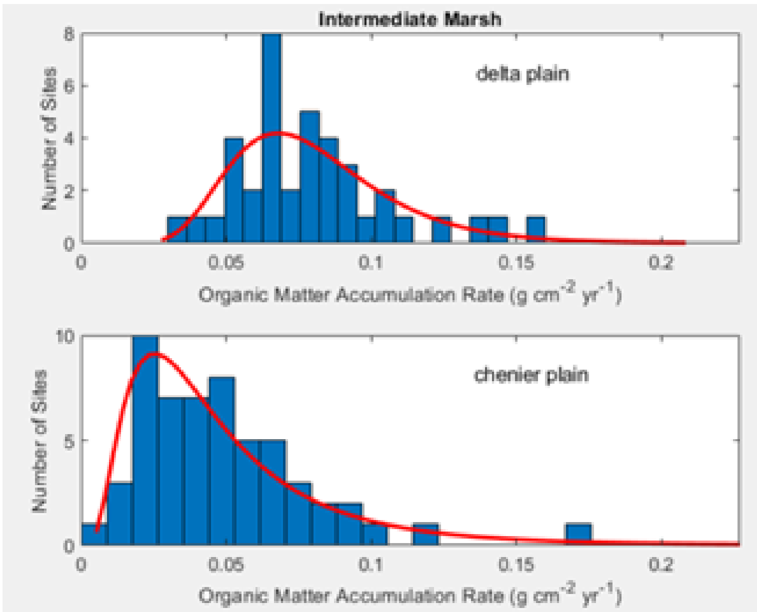


Figure 22. Lognormal distributions of OMAR values for Intermediate Marsh CRMS sites in the delta plain (top) and the Chenier Plain (bottom).

For active delta sites, which are assumed to be fresh marsh, we took OMAR values calculated from four CRMS sites that include locations in the Bird's Foot Delta (CRMS2608 and 2634), the Atchafalaya Delta (CRMS6304), and the Wax Lake Delta (CRMS0479) (Figure 23). More CRMS sites exist in active delta areas, but no vertical accretion data were available to calculate OMAR. OMAR rates for swamp were not partitioned as there are no available swamp data for the Chenier Plain.

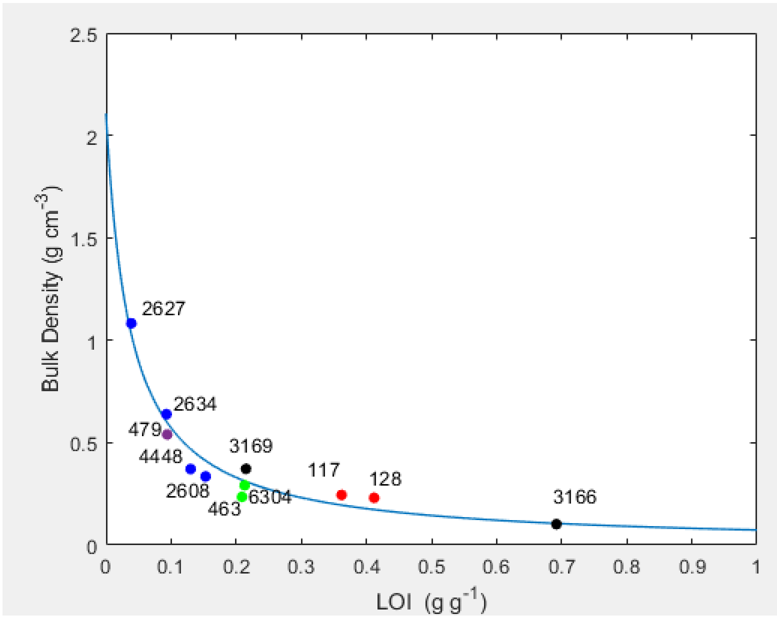


Figure 23. Bulk density and organic matter content of wetland soils from CRMS sites in active deltaic areas. Blue = Bird's Foot Delta, red = Breton Basin, black = Barataria Basin, green = Atchafalaya Basin, and purple = Wax Lake Delta.

Geometric means and upper/lower bounds were determined from CRMS data for each habitat type coastwide and for each habitat type/region combination to provide input to a lookup table in ICM-Morph (Table 3). Bounds are not included for the saline/chenier or the active delta categories because the sample sizes for these were 3 and 4, respectively.

Table 3. Organic Matter Accumulation Rates (OMAR) derived from CRMS data (g cm^{-2} yr^{-1})

		Delta Plain		Coastwide
	Chenier Plain	Inactive	Active	
Fresh	0.058 (0.040, 0.085)	0.089 (0.073, 0.107)	0.145	0.076 (0.063, 0.091)
Intermediate	0.040 (0.033, 0.048)	0.076 (0.068, 0.085)		0.052 (0.046, 0.059)
Brackish	0.042 (0.035, 0.050)	0.065 (0.058, 0.074)		0.056 (0.050, 0.062)
Saline	0.038	0.082 (0.070, 0.097)		0.079 (0.067, 0.093)

	Chenier Plain	Delta Plain		Coastwide
		Inactive	Active	
Swamp Forest*	0.093 (0.079, 0.110)			0.093 (0.079, 0.110)

*When OMAR is applied in the model, the "swamp forest" values shown are used for the forested wetland habitat type, which includes swamp and bottomland hardwood species.

The OMAR values recommended in Baustian et al. (2020) and tested for G027 applied values of 0.089 (fresh), 0.062 (intermediate), 0.063 (brackish), and 0.093 g cm^{-2} yr^{-1} (saline). Note that while the values proposed here are lower than those in the recommendation report, they may still be a bit high relative to observations (as a result of using short-term feldspar accretion values instead of more long-term accretion values based on 137Cs and 210Pb dating). See Supplemental Material D2.2: Differences in Organic Matter Accumulation Rates along the Louisiana Coast that examines this further.

The partitioning approach, which was applied for G030 and G031, also requires development of a method to spatially differentiate active versus inactive deltas in the model. For the sake of the test runs, ICM-Hydro compartments in the areas of known active deltas (e.g., Wax Lake, Atchafalaya, and the Bird's Foot Delta) were flagged as active delta areas, and the OMAR rate for active deltas was applied for fresh wetlands in those areas. The team will need to examine results from the test runs (e.g., for Wax Lake) to determine the final process to be used for spatially differentiating active delta areas for production runs, including for areas where new deltas are expected (i.e., diversion outfall areas).

OTHER MODEL CHANGES

In addition to the ICM-LAVegMod modifications adjusted from updates tested in G029 and additional changes in ICM-Morph recommended by the team (described above), these test runs include a few other ICM updates as part of integration and model testing for the 2023 ICM. Since updates to ICM-Hydro were ongoing in parallel, these test runs used ICM-Hydro outputs from the 2017 Coastal Master Plan Future Without Action (FWOA), medium scenario run (G300S04). An updated version of ICM-Morph, coded in Fortran, was used for the test runs, but since sediment calibration was still underway, sediment deposition was fixed for the test runs (i.e., every year, the same amount of mineral sedimentation was applied to each cell). This approach still allowed for dynamic linking of annual land change and vegetation updates, which was missing for test runs G028 and G029 (due to using 2017 outputs for ICM-Morph). Finally, new subsidence rates developed for the 2023 Coastal Master Plan were applied for the test runs along with sea level rise and other inputs from the medium environmental scenario from the 2017 Coastal Master Plan (S04).

EVALUATION OF RESULTS

The focus of this evaluation was on vegetation distribution, organic matter accumulation rates, and assessing that the salinity-inundation loss mechanism was causing land loss under the expected conditions for non-fresh marshes. Due to simplifying assumptions and issues identified related mineral sediment deposition, the evaluation could not fully consider changes in land area or the amount of land loss. However, specific local changes in wetland survival were examined. Also, as the full array of outputs was not available the inundation of upland (not mod) areas could not be evaluated. Evaluation of the effects of highwater on fresh marsh inundation can be better undertaken when inundation maps are available.

Prior to test runs G030 and G031, the following effects were hypothesized and the results were examined for such effects:

- Vegetation Distribution, Wetlands area, and land cover type:
    - Persistent areas of forested wetland in Maurepas and Upper Barataria (with updated FFIBS scores)
    - Flotant: Panicum (thick mat) persists more than Eleocharis (thin mat) with changing conditions
    - Establishment of high dispersal species on new built land isolated from other sources of propagules
    - Transition of bareground that persists for several years to open water because of bareground_old lowering effects may be greater in later years of the simulation when water level rise is more rapid
    - Progressive increases in inundation depth associated with sea level rise and subsidence in areas without active land building to similarly raise marsh elevation, will lead to land loss even if the salinity remains the same (the blue line will be crossed)
- Elevation (with focus on organic accretion):
    - Accretion occurs in areas without flooding and in areas with no mineral sediment deposition
    - Higher accretion in fresh and saline marshes compared to intermediate and brackish with similar mineral inputs (based on geometric means from an updated OMAR table - see above)
    - Similar results between test runs G030 and G031 but with less differences in accretion between vegetation types for G031, as the organic matter accretion results will have smoother transitions because of the interpolation/weighted averaged approach

2.2 RESULTS

Examination of the changes in distribution of habitat types (FFIBS plus flotant), wetland area, and elevation were based on comparison of test run G030 and test run G031 to each other, over time, and to test run G029. To some degree, comparisons were made to G300S04 from the 2017 Coastal Master Plan and G027 (the previous test of a new OMAR lookup table approach), noting that results from these runs that used older versions of ICM-Hydro and ICM-Morph are not easily comparable to the test runs due to additional updates included.

Review of results for the test runs focused mainly on outputs related to evaluating new updates in ICM-Morph, but the team had also recommended continuing to track the effects of several ICM-LAVegMod changes previously tested in G029 as well, including:

- Whether high dispersal class dominates where new deltaic land is built into an open water body where existing fresh marsh is not available as a source for dispersal
- Occurrence of black mangroves on the Chenier Plain
- Distinction between Eleocharis flotant (thin mat) vs. Panicum flotant (thick mat), and response to changing conditions. Note, however, that G030 and G031 initial vegetation maps do not have PAHE2_flt. It was removed due to issues tracking flotant between LAVegMod and Morph. It was random for G028 and G029.

For these test runs, model output was available from various points across the coast, including CRMS stations, selected transects, and random points for each ecoregion (Figure 24).

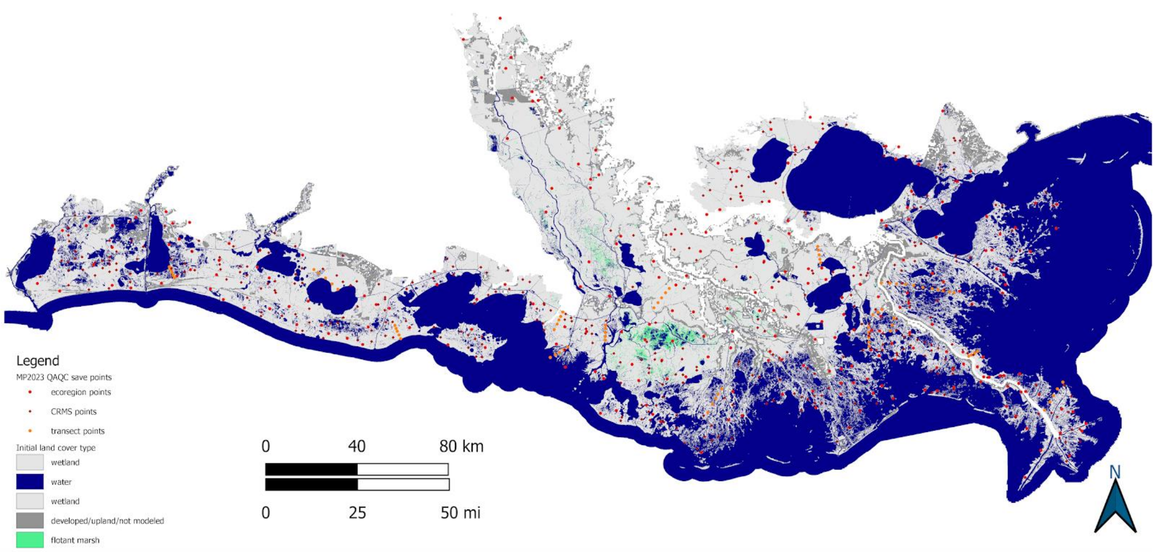


Figure 24. Map of data save points for model outputs.

2.3 SUMMARY OF FINDINGS

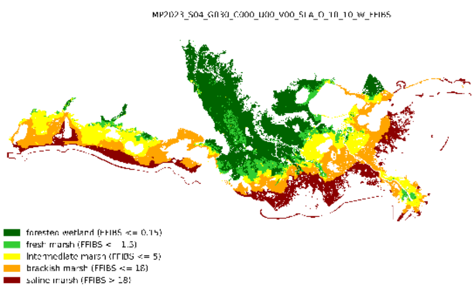
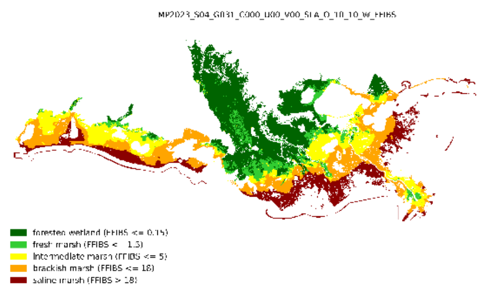
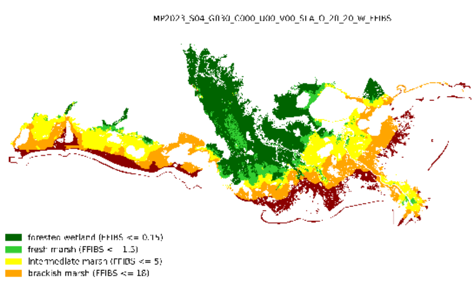
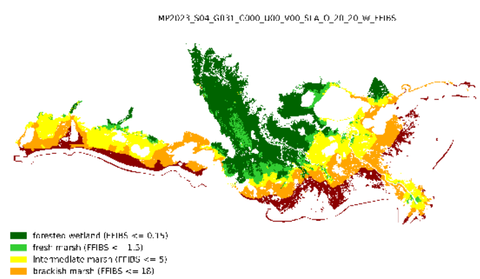
The results of the test runs can be summarized in relation to the effects which were hypothesized in advance.

VEGETATION DISTRIBUTION AND WETLAND AREA

VEGETATION DISTRIBUTION

Observations of coastwide patterns of vegetation distribution (Figure 25) include:

- No noticeable difference in vegetation types between the two runs,
- Land created at the domain boundary that should not be there, and
- Gradual shifts in vegetation types overtime with occasional large jumps (e.g., Upper Barataria switches from forested to intermediate in one year).

G030	G031
10 	10 
20 	20 

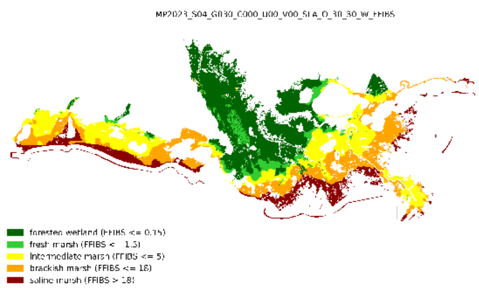
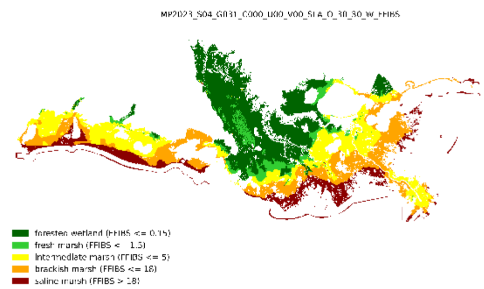
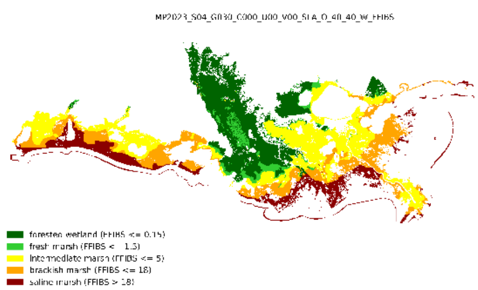
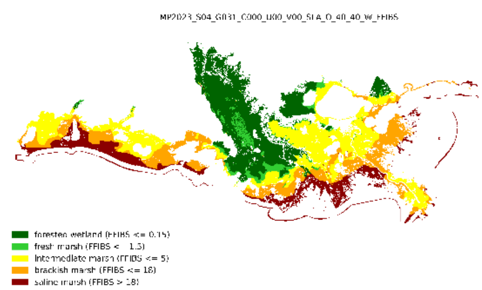
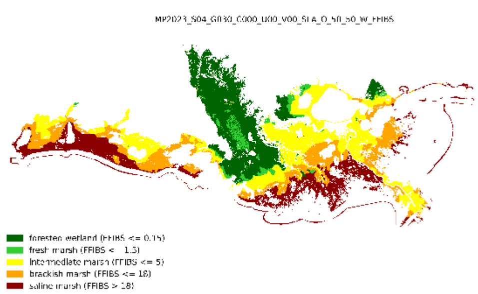
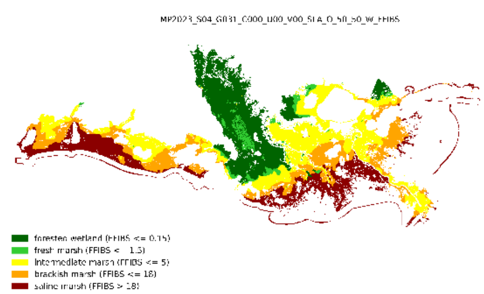
G030	G031
30 	30 
40 	40 
50 	50 

Figure 25. Coastwide patterns of vegetation for G030 (left) and G031 (right) at Years 10, 20, 30, 40, and 50.

Figure 26 shows vegetation distribution over time for a poldered area, Golden Meadow to Larose, in Year 1. With most of the upland area mapped as forest. Because areas within polders are expected to be managed over time, we cannot realistically predict vegetation change here. These areas will be removed from the updated ICM-LAVegMod grid for 2023 Coastal Master Plan production runs.

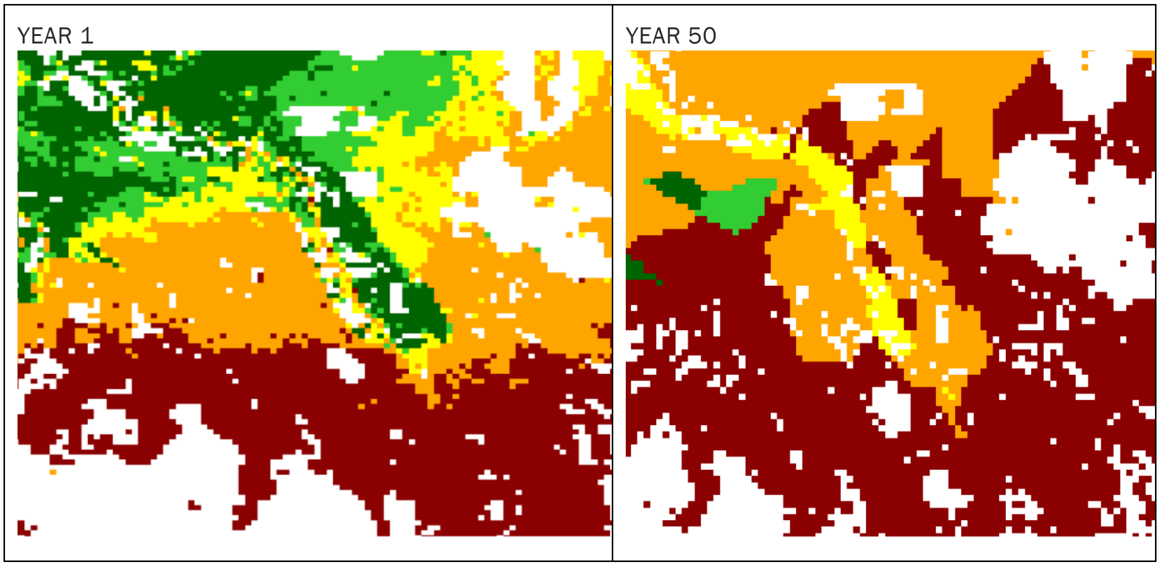
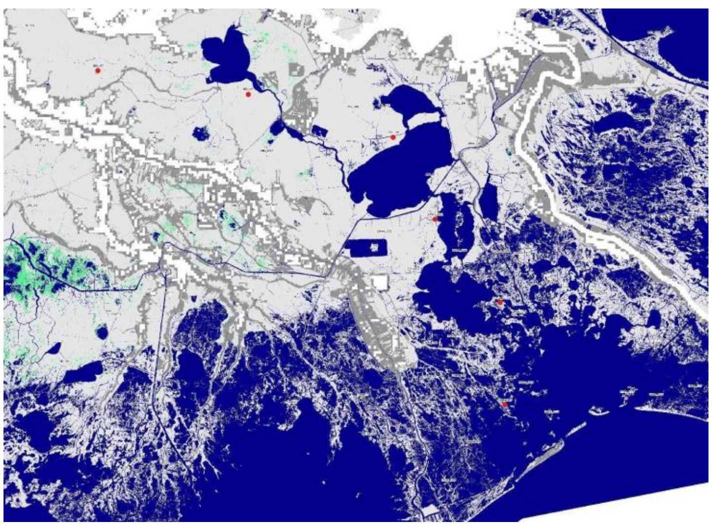


Figure 26. Zoomed in view of vegetation distribution in the Golden Meadow to Larose area in Year 1 (left) and Year 50 (right).

To more closely examine changes in vegetation coverage over time for a range of habitat types, the team looked at results from data save points along a transect through Barataria Bay.



HABITAT	DATA SAVE POINT ID
SWAMP	UBA_407
FRESH MARSH	UBA_445
FRESH-INTERMEDIATE	MBA_1804
INTERMEDIATE	LBANW_1211
BRACKISH	LBANW_1206
SALINE	LBASW_1417

Figure 27. Map of data save point transect through Barataria Basin (top) with habitat types by station ID (bottom).

Figure 28 shows change in vegetation coverage over time for UBA-407. At the start of the simulation, this site is a swamp forest with almost equal amounts of cypress (TADI2) and tupelo (NYAQ2). There is no apparent difference in vegetation changes between the two runs. Over the first 39 years, both tree species steadily decline and are replaced by wax myrtle (MOCE2). At Year 40, there is an event that eliminates the wax myrtle, and cattail (TYDO) dominates for the next seven years until the vegetation becomes dominated by Roseau cane (PHAU7). In Year 44, the small but stable amount of thin-mat flotant (ELBA2_FLT) is lost and converts to open water.

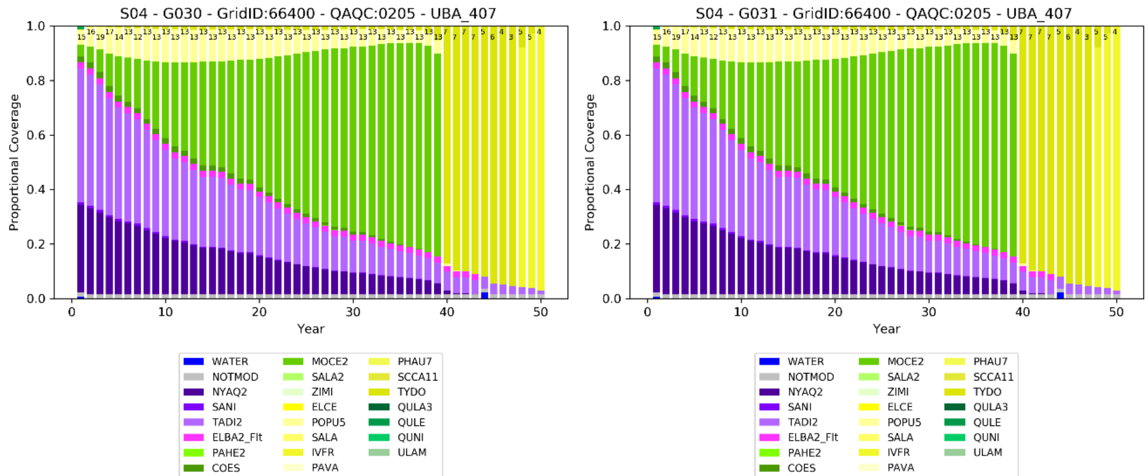


Figure 28. Vegetation coverage over time for G030 (left) and G031 (right) at data save point UBA-407 (swamp site).

Figure 29 shows change in vegetation coverage over time for UBA-445. At the start of the simulation, this site is dominated by maidencane (PAHE2). There is no apparent difference in vegetation changes between the two runs. In both runs, maidencane rapidly declines in the first seven years and then less rapidly over the next 25 years. In the first seven years, maidencane is primarily replaced by smartweed (POPU5), bulltongue (SALA), and cattail (TYDO). Until Year 33, wax myrtle (MOCE2) expands, and over the next ten years, cattail become more and more dominant. In Year 43, there is another event that makes paspalum (PAVA) dominant for the rest of the simulation.

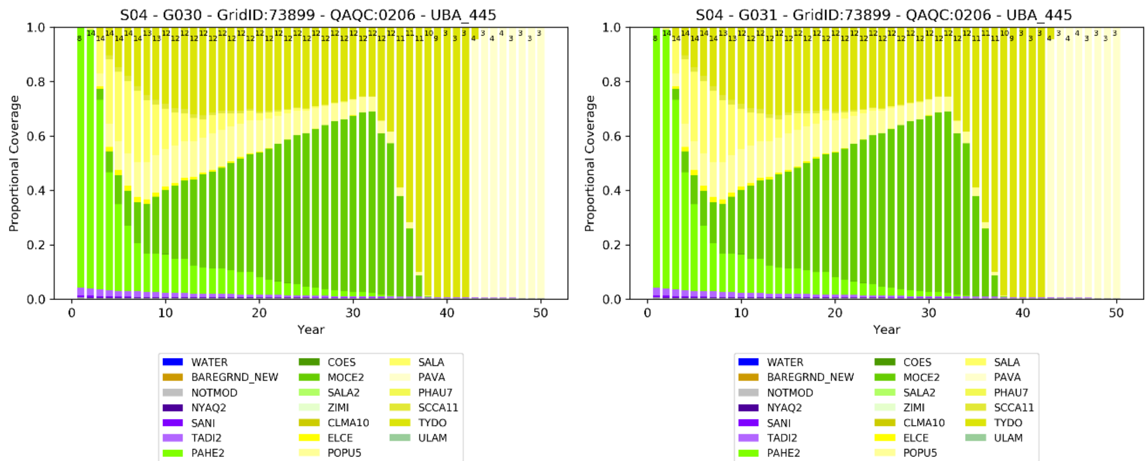


Figure 29. Vegetation coverage over time for G030 (left) and G031 (right) at data save point UBA-445 (fresh marsh site).

Figure 30 shows change in vegetation coverage over time for MBA_1804. At the start of the simulation, this site is dominated by bulltongue (SALA). Although there is no apparent difference in vegetation changes between the two runs, there is slightly higher land loss (i.e., transition of vegetated land to water) in G031. There is a slight loss of land that starts in Year 36 in both runs. This is the year where cattail (TYDO) is starting to be replaced by paspalum (PAVA), which indicates that salinity is increasing. In G031, there is a second land loss event in Year 47.

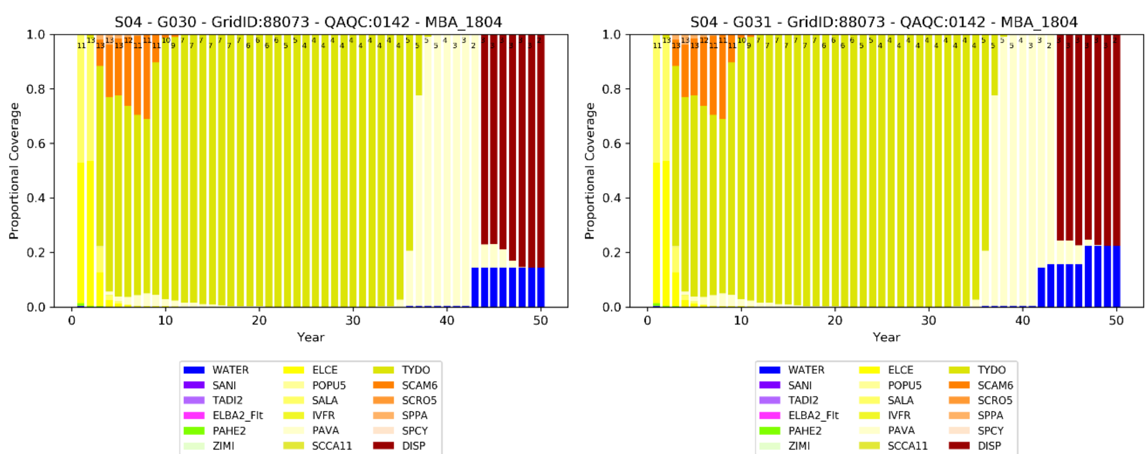


Figure 30. Vegetation coverage over time for G030 (left) and G031 (right) at data save point MBA_1804 (fresh-intermediate marsh site).

Figure 31 shows change in vegetation coverage over time for LBANW_1211. This site is dominated by water, but it shows no difference in land loss or vegetation change between the two runs. This cell that has flotant that hangs on even as brackish attached marsh is disappearing. The salinity and water level variability conditions are OK for ELBA2 until Year 29, when the 2-week salinity threshold is crossed. It all disappears that year. In Year 30, the cell is 100% water. In Year 31, we see a pattern of attached marsh coming back in place of flotant. This is an issue being addressed in further updates for 2023 Coastal Master Plan model runs.

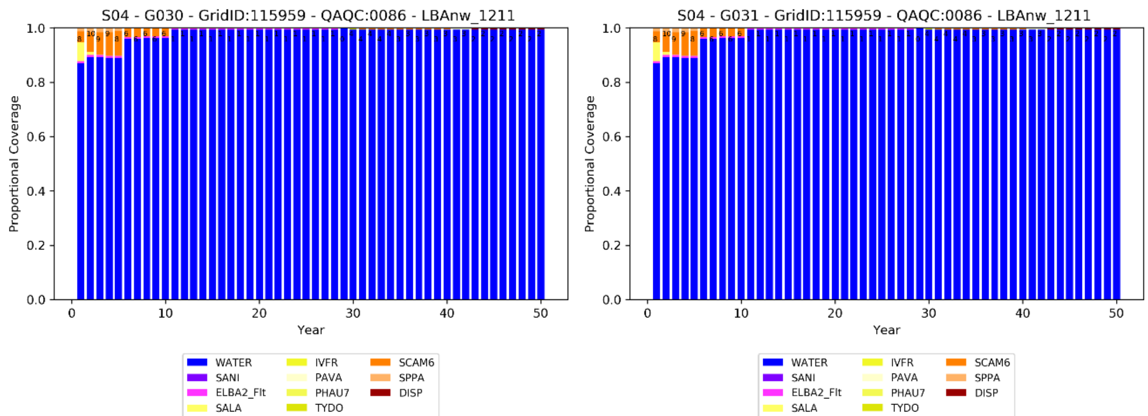


Figure 31. Vegetation coverage over time for G030 (left) and G031 (right) at data save point LBANW_1211 (intermediate marsh site).

Figure 32 shows change in vegetation coverage over time for LBANW_1206. At the start of the simulation, this site is a mixture of primarily wiregrass (SPPA) and black needlerush (JURO). There is not much difference in changes in species composition between the two runs, and overall land loss has a similar trend. However, between Year 30 and 40, land loss is more smooth in G030 than in G031. By the end of the simulation, the remaining marsh is dominated by oyster grass (SPAL).

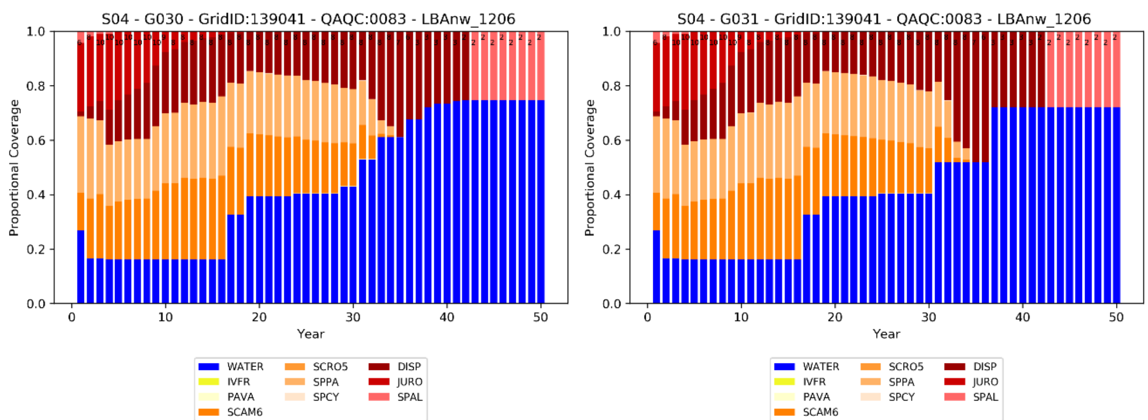


Figure 32. Vegetation coverage over time for G030 (left) and G031 (right) at data save point LBANW_1206 (brackish marsh site).

Figure 33 shows change in vegetation coverage over time for LBASW_1417. This is a saltmarsh station that is dominated by oyster grass (SPAL). By Year 7, the JURO is 0 for both G030 and G031, and the values for SPAL and water between the two runs are the same. After Year 7, the site only contains oyster grass.

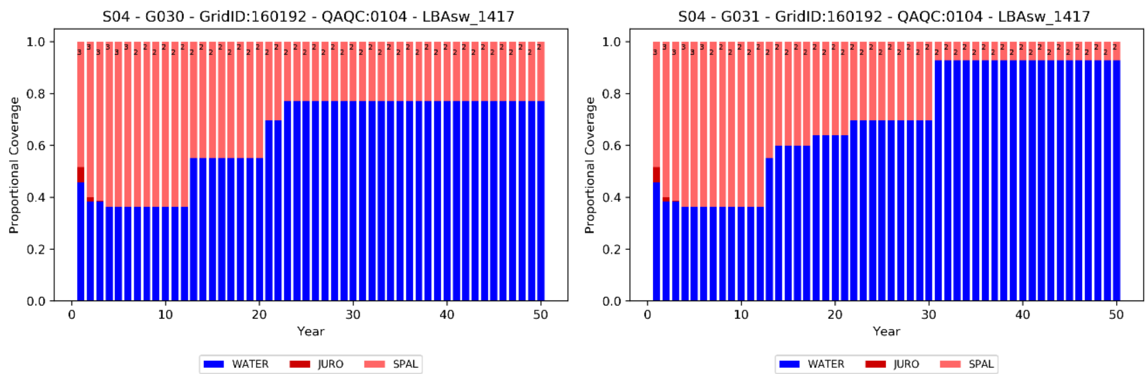


Figure 33. Vegetation coverage over time for G030 (left) and G031 (right) at data save point LBASW_1417 (saline marsh site).

To examine the changes in flotant marsh we examined four data save points located in areas with extensive floating marshes, the same locations evaluated for G028 and G029 (Figure 34).

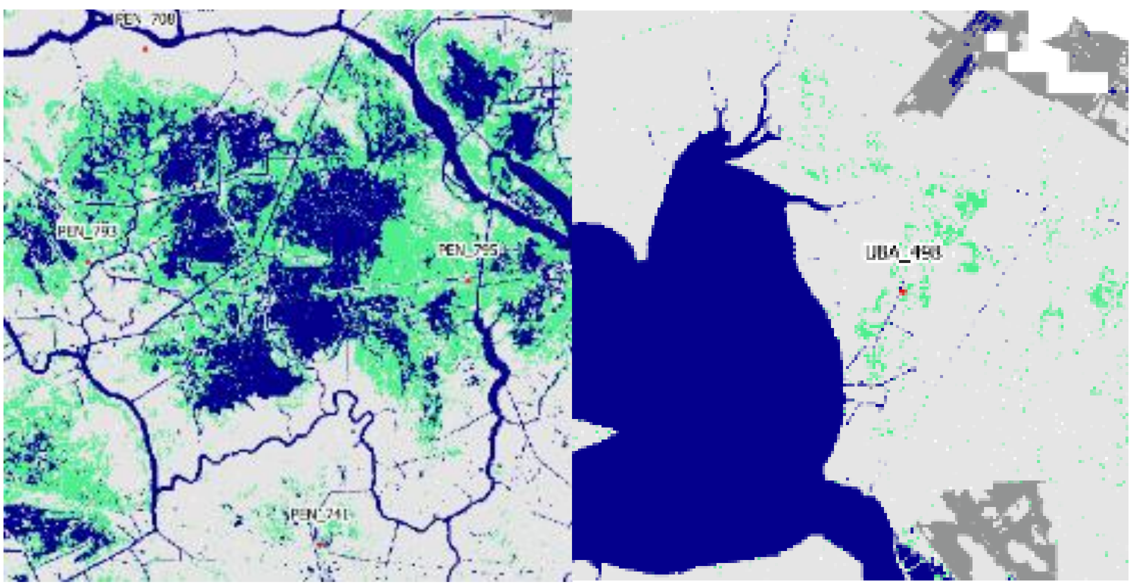


Figure 34. Zoomed in maps showing locations of data save points in areas with extensive floating marsh: PEN_795, PEN_793, and PEN_741 (left) and UBA_498 (right).

Figure 35 shows change in vegetation coverage over time for PEN_795 (VEGMOD 133260). This site is located just west of Bayou Copesaw in Terrebonne Parish in an area dominated by thin-mat flotant (ELBA2). Attached maidencane (PAHE2) and wax myrtle (MOCE2) expand and replace intermediate marsh species (TYDO, SALA). In these test runs, we do not see the conversion of most fresh and floating marsh to open water observed in G028 and G029 which used a different environmental scenario and thus different hydrology. The initial vegetation map also differs.

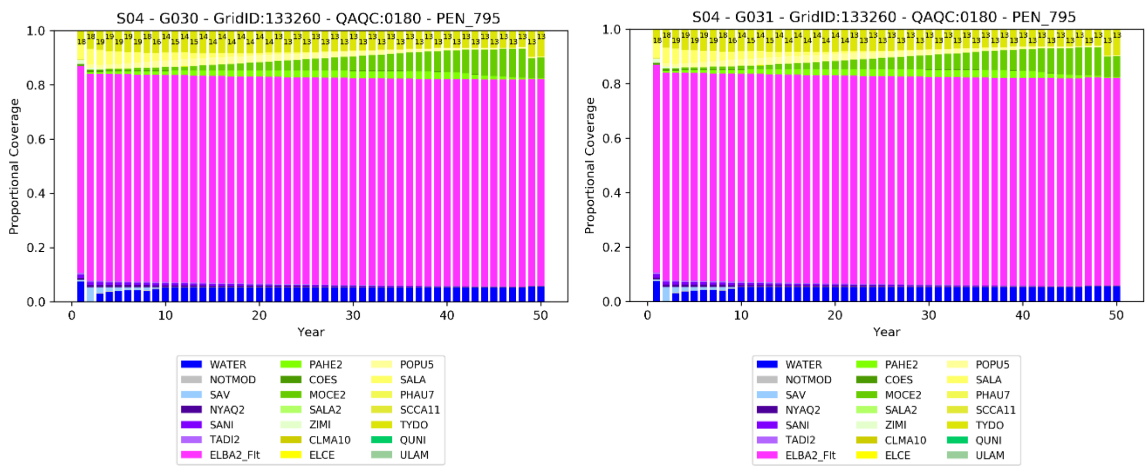


Figure 35. Vegetation coverage over time for G030 (left) and G031 (right) at data save point PEN-795.

Figure 36 shows change in vegetation coverage over time for PEN_793 (VEGMOD 132526). This site is located just west of Turtle Bayou in Terrebonne Parish in an area that receives increasing back flooding of the Atchafalaya River. In this area flotant mostly consist of thin-mat (ELBA2). Trends show stable thin-mat flotant (ELBA2) with an increase in willows (SANI) in the first few years followed by a slow decline and increasing wax myrtle (MOCE2) and maidencane (PAHE2). Water area slowly increases starting in Year 35.

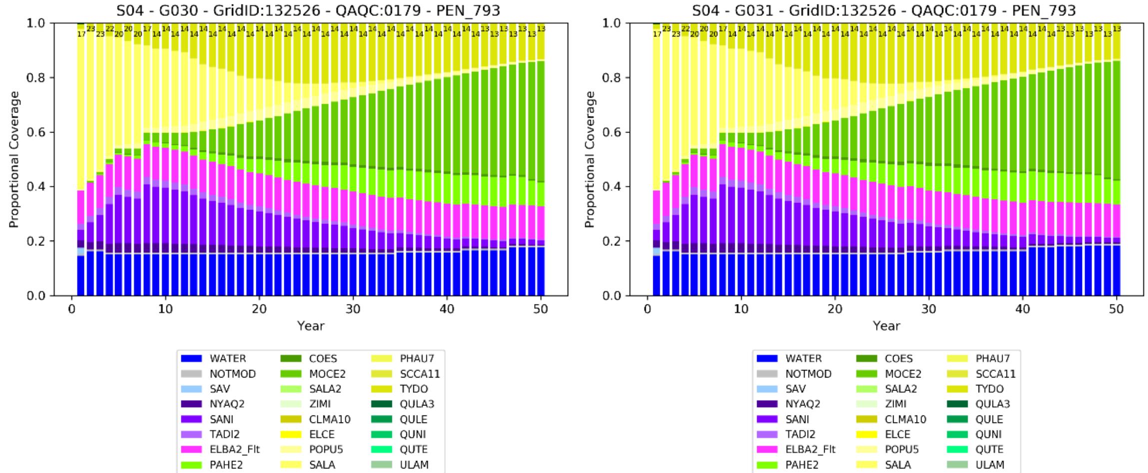


Figure 36. Vegetation coverage over time for G030 (left) and G031 (right) at data save point PEN-793.

Figure 37 shows change in vegetation coverage over time for PEN_741 (VEGMOD 144437), located south of Bayou Penchant in Terrebonne Parish in an area that is primarily dominated by bulltongue (SALA) and cattail (TYDO). In this area, the small amount of maidencane (both attached and flotant) disappears in the first 10 years. Thin-mat flotant (ELBA2) remains relatively stable. Flotant is converted to open water in Year 49. The expansion of attached marsh into the area previously occupied by flotant should be examined and addressed for future runs.

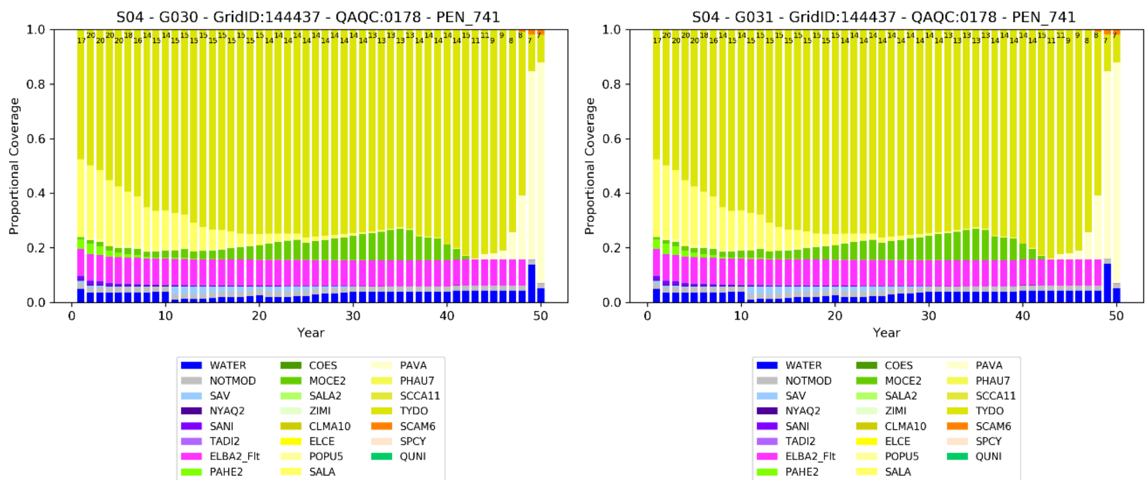


Figure 37. Vegetation coverage over time for G030 (left) and G031 (right) at data save point PEN-741.

Figure 38 shows change in vegetation coverage over time for UBA_498 (VEGMOD 59767). This site is located east of Lac des Allemands. Trends are similar to other points with declining PAHE2 (both floating and attached) with flotant converting directly to attached marsh. The flotant becomes dead_flt and is added to water. The percent water from morph for the following year is small, which creates bareground for vegetation to establish.

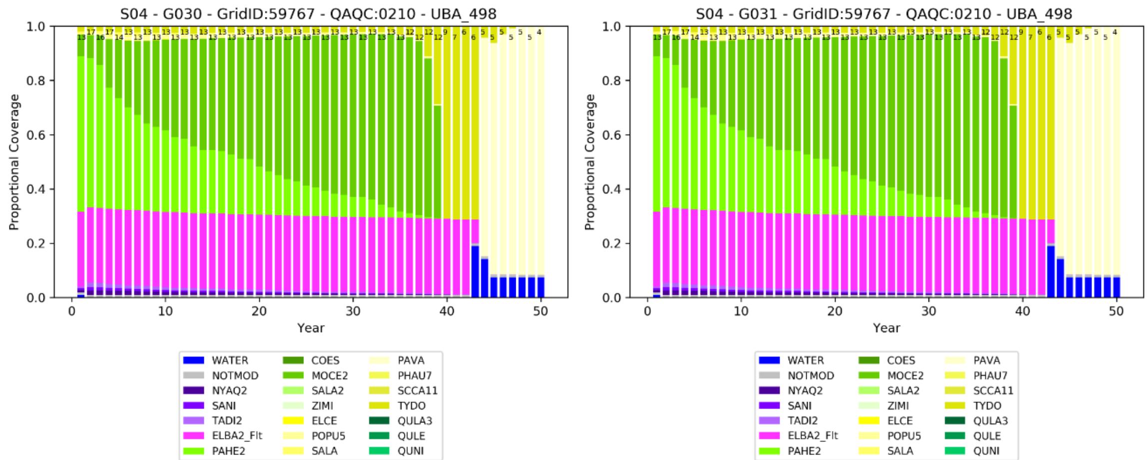


Figure 38. Vegetation coverage over time for G030 (left) and G031 (right) at data save point UBA-498.

WETLAND AREA AND LAND LOSS

Land change maps show complex patterns of loss across the coast in both G030 and G031, which also vary from year to year (Figure 39).

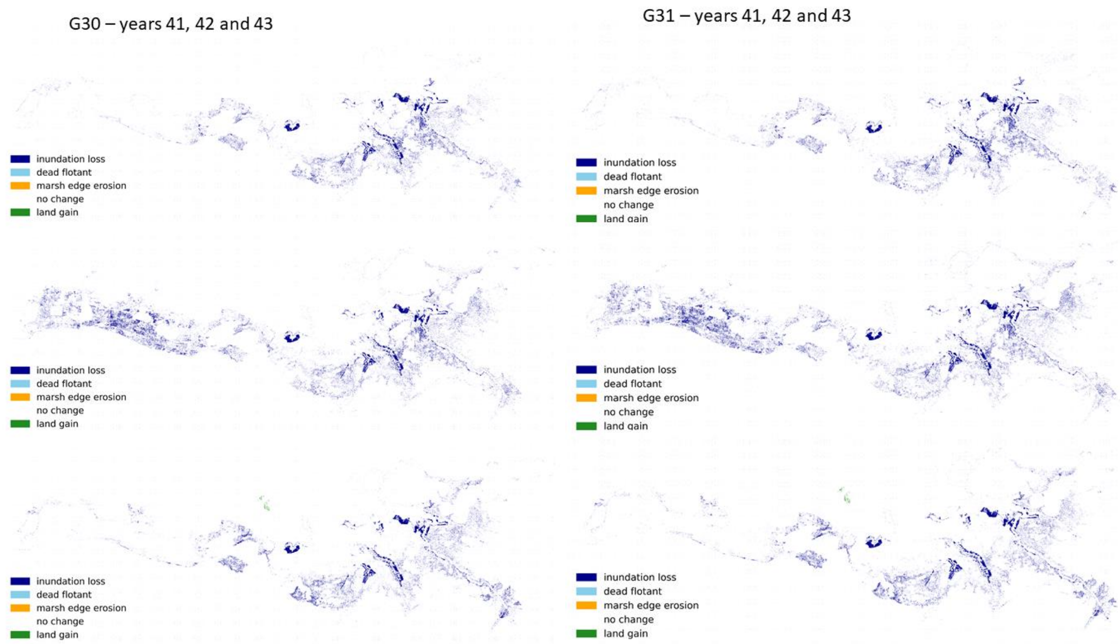


Figure 39. Land loss for G030 (left) and G031 (right) at Years 41 (top), 42 (middle), and 43 (bottom).

Due to issues with sediment deposition and mineral accretion values in the G030 and G031 test runs, this evaluation could not fully assess changes in land area or the amount of land loss. The assessment here discusses some of the changes that may be associated with vegetation and salinity-inundation conditions.

The loss in any year is dependent on the conditions in that year and the year before (i.e., the 'blue line' needs to be exceeded for two consecutive years) and also on the land loss in previous years. Land can only be lost if it still exists, so comparisons at a single year do not take into account that land may not be available to be lost. Figure 40 shows the cumulative effects of land loss by Year 42 for Marsh Island. Close inspection indicates greater land loss in G031 than in G030.

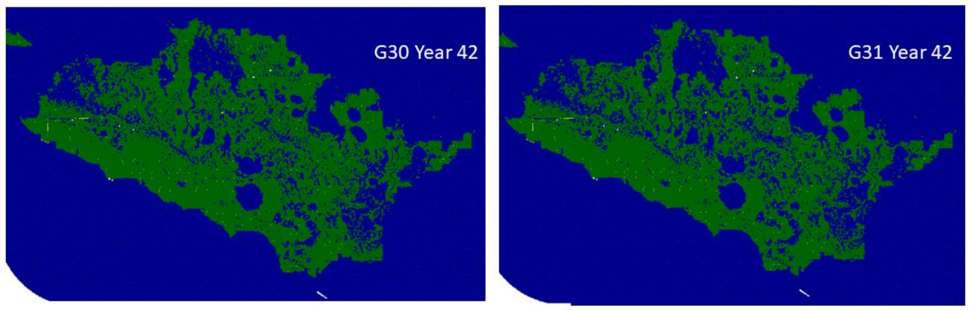


Figure 40. Land at Year 43 for G030 (left) and G031 (right).

Patterns of land loss vary by location. Figure 41 shows vegetation and land-water changes at TVB_517, a location toward the eastern end of Marsh Island. At this 500 m x 500 m ICM-LAVegMod cell there is greater land loss by ~Year 28 in G030 than in G031 but greater land loss by Year 50 in G031.

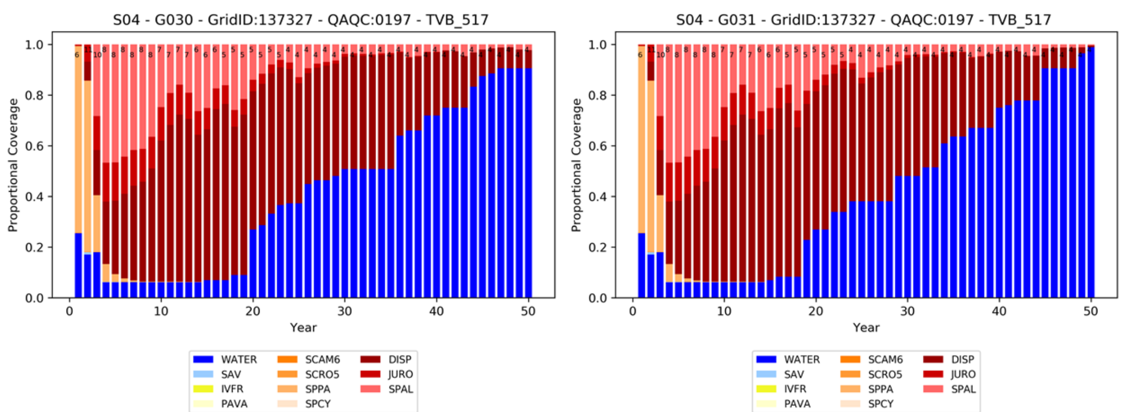


Figure 41. Vegetation coverage over time for G030 (left) and G031 (right) at data save point UBA-498.

The hydrology input for these test runs is from run G300S04 from the 2017 Coastal Master Plan for both simulations. Figure 42 shows the hydrology influencing the land loss for one of the 30 m ICM-Morph pixels within the ICM-LAVegMod grid cell shown above. Inundation depth is calculated using land elevation, which varies by 30 m pixel. Note that this specific pixel remains land throughout the 50-year simulation. Inundation depth increases throughout the simulation due to sea level rise and subsidence (which are the same for G030 and G031 - the total rate is 10.39 mm/yr for this cell) as well as wetland soil accretion. This particular site is very high in the tidal frame as shown by negative inundation depths in early years of the simulations.

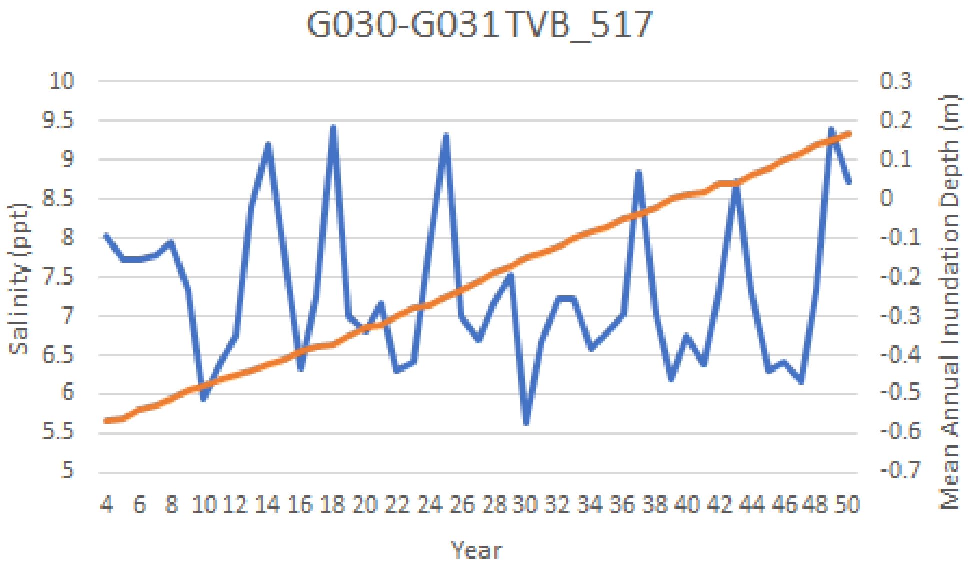


Figure 42. Hydrology input from G300SO4 for one ICM-Morph pixel within UBA-498, applied for both G030 and G031. Blue – salinity; red – mean annual inundation depth.

Differences in land loss in the UBA-498 may be a result of changing FFIBS scores over time (there are some minor difference between the runs in the last decade – see below) but also due to the interpolation approach for OMAR based on FFIBS score that was applied in G031 but not in G030. As Marsh Island is considered part of the Chenier Plain, OMAR rates for saline marsh (FFIBS scores greater than 18) are lower than for brackish marsh. The changing mix of vegetation shown above (in the cell land cover bar plots) means that in G030 the OMAR (and thus the organic accretion shown in the plot below) is switching between higher and lower values. For G031, organic accretion stays almost constant (constant for FFIBS values above 18), and the interpolation approach leads to lower than the brackish OMAR value for scores approaching 18.

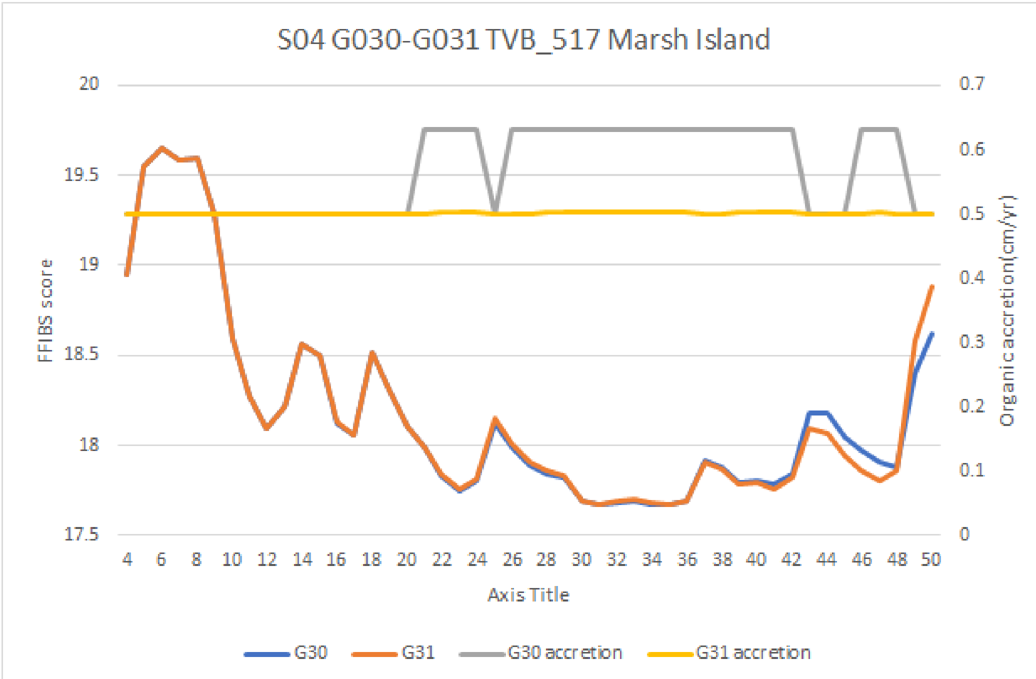


Figure 43. FFIBS score and organic accretion for UBA-498 over time for G030 and G031.

EFFECT OF SALINITY AND INUNDATION DEPTH ON LAND LOSS PATTERNS

Conversion of vegetated wetlands (and bareground) to open water requires that salinity and inundation conditions exceed threshold values, shown by the upper blue line in Figure 44, for two consecutive years. These values were determined based on the water depth limitation of vegetation occurrence from CRMS sites (Baustian et al., 2020).

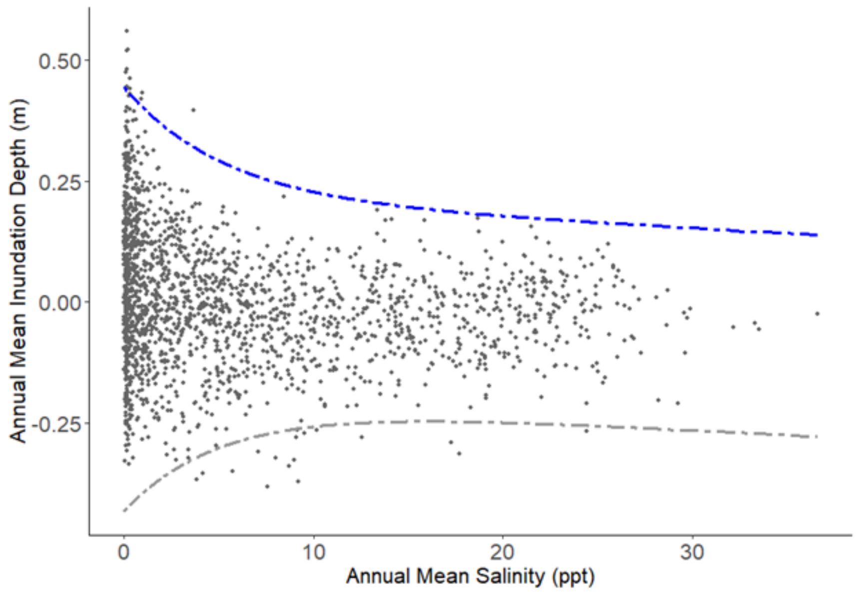


Figure 44. Water depth limitation (by salinity) for vegetation.

Three sites along transect 13 were used to assess the approach to land loss (Figure 45).

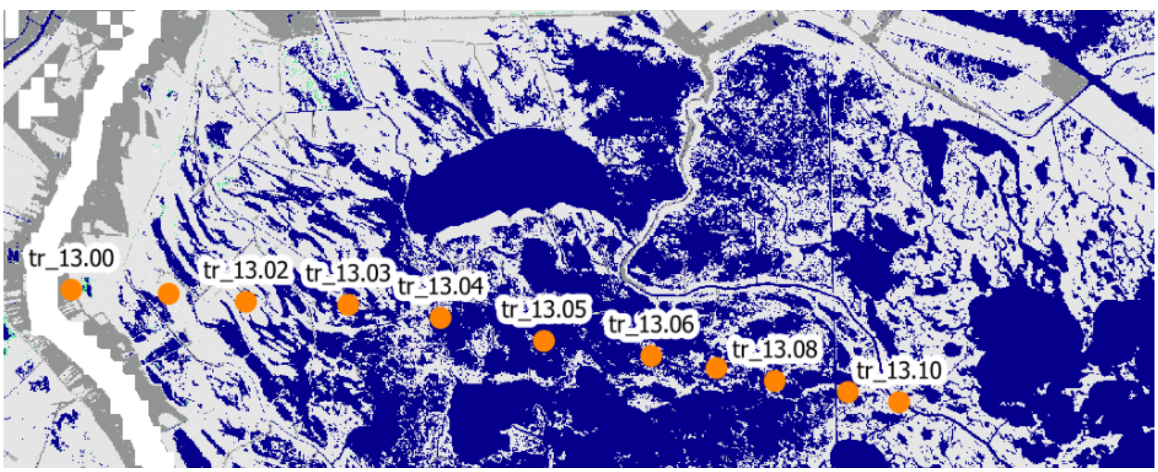


Figure 45. Transect 13 in Breton Basin (TR-13).

Figure 46 shows conditions over time at the first site on the transect, where the marshes are intermediate. This specific pixel converts from land to water in Year 37 (shown by the vertical red line). Salinity is low but has been increasing in the previous two years, reducing the inundation depth threshold. Inundation depth is increasing and the two year condition is met resulting in loss at Year 37.

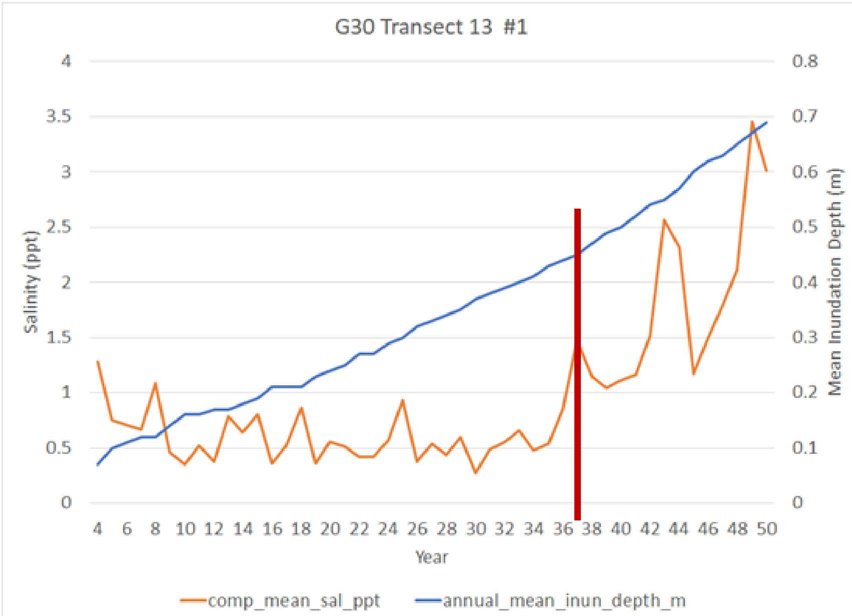


Figure 46. Conditions over time for Transect 13, site 1.

At location 6 on the same transect (Figure 47), vegetation changes from brackish to intermediate and then back to brackish in the last decade as salinities increase. The pixel shown above converts to open water in Year 36 at a slightly lower inundation depth than site 1 as salinity is slightly higher.

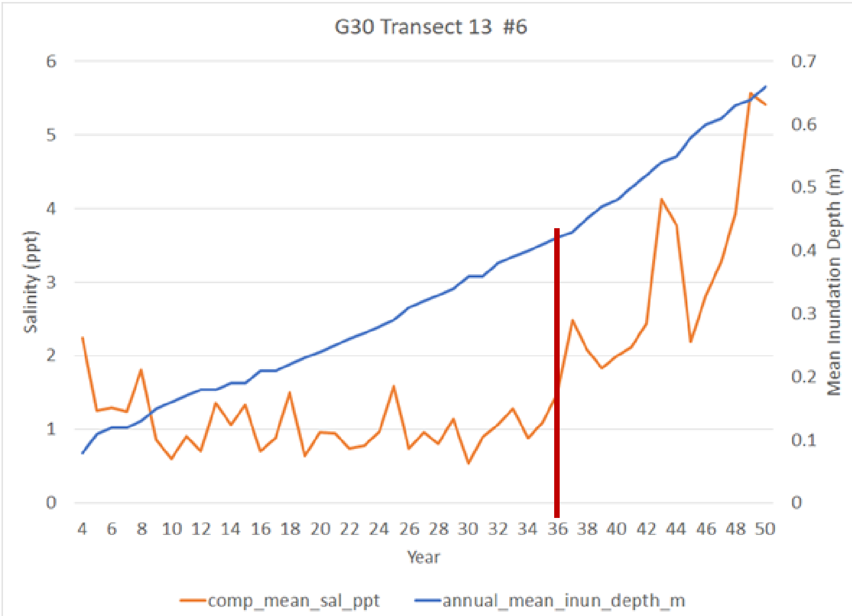


Figure 47. Conditions over time for Transect 13, site 6.

At location 10 on the same transect (Figure 48), salinities are generally high and brackish marsh dominates with increasing saline marsh in the last decade. The example pixel shown above is relatively high in the tidal frame. The inundation depth does not exceed the threshold line, so the pixel remains land throughout the simulation.

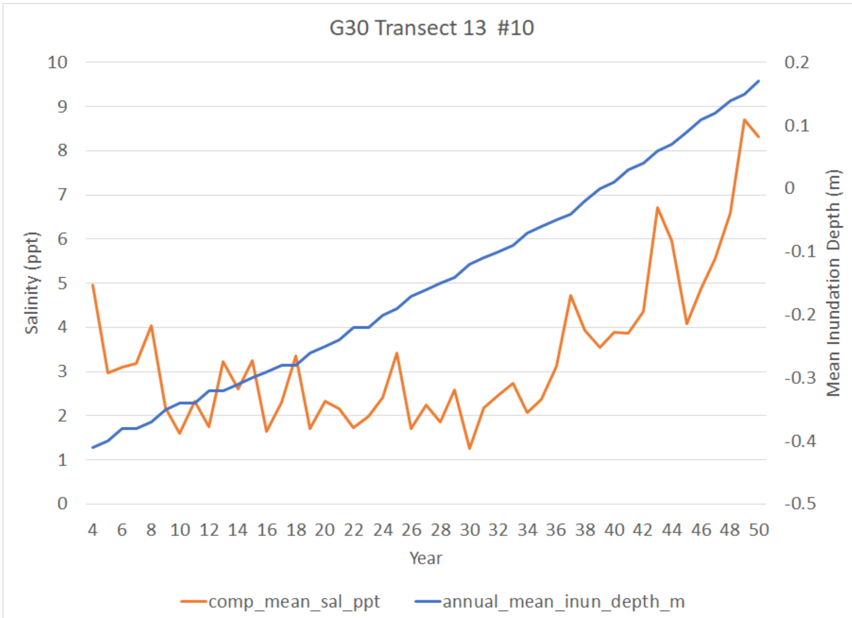


Figure 48. Conditions over time for Transect 13, site 10.

ELEVATION CHANGE

Three transects were examined to evaluate elevation change for these test runs, Transect 13 (Figure 48) and Transects 3 and 8 (Figure 49), with a focus on changes in organic matter accumulation rates and resulting organic matter accretion.

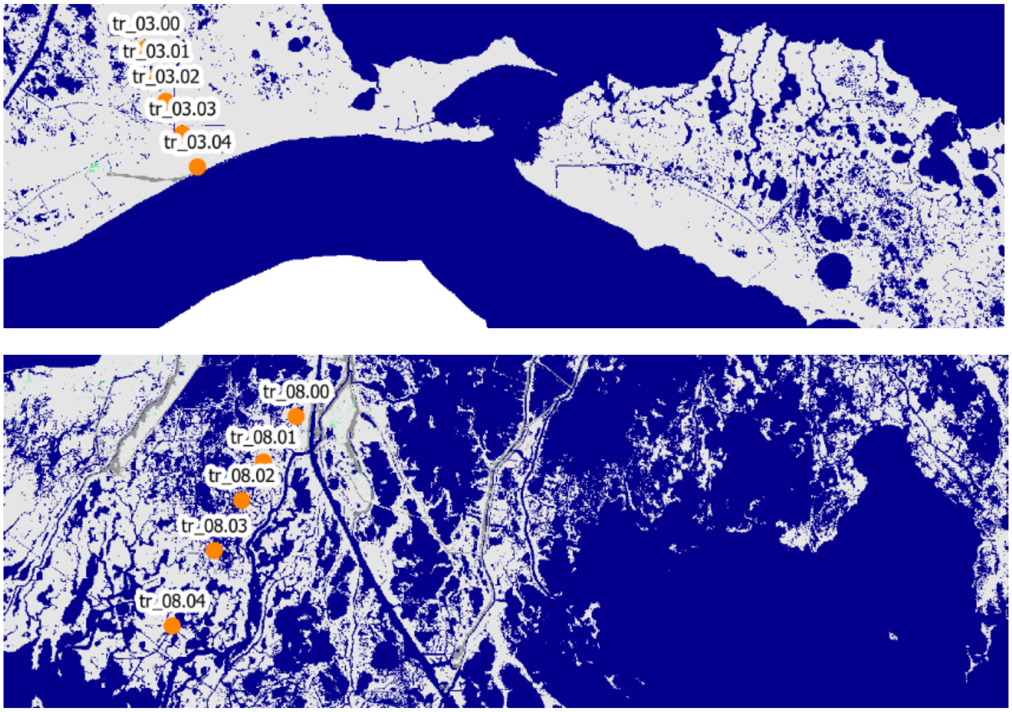


Figure 49. Transect 3 (TR_03) in Teche-Vermilion Basin on the Chenier Plain (top) and Transect 8 (TR_08) in Terrebonne Basin (bottom).

ACCRETION IN AREAS WITHOUT FLOODING AND WITH NO MINERAL SEDIMENT DEPOSITION

Output from three transects (TR_03, TR_08, TR_13) was reviewed to test the hypothesis that accretion can occur in areas that are not flooded (with zero annual mean inundation) and do not receive mineral sediment deposition in the test runs. The tables below summarizes the sites on the transect where a zero annual mean inundation depth was observed and the corresponding organic matter accretion for that particular year. It was found that organic matter accretion is occurring in the model even with no flooding.

Table 4. Annual Mean Inundation and Organic Matter Accretion by data save point*

MODEL TEST RUN	TRANSECT	SITE	YEAR	ANNUAL MEAN INUNDATION DEPTH (M)	ORGANIC MATTER ACCRETION (CM)
G030	TR_03	0	6	0	0.63
		1	49	0	0.63

MODEL TEST RUN	TRANSECT	SITE	YEAR	ANNUAL MEAN INUNDATION DEPTH (M)	ORGANIC MATTER ACCRETION (CM)
		2	21	0	0.63
		4	50	0	0.50
	TR_13	2	47	0	1.00
		10	39	0	0.86
G031	TR_03	1	46	0	0.51
		2	19	0	0.51
		4	50	0	0.50
	TR_08	2	18	0	0.90
	TR_13	2	45	0	0.95
		10	41	0	0.93

*An OMAR value of O.48 was mistakenly applied for brackish marshes in the Chenier Plain for G031 (which, when divided by K1, gives 0.63 cm/yr for accretion). The correct value is 0.42, which gives an organic accretion rate of 0.55 cm/yr. This mistake has been corrected in the lookup table used by ICM-Morph for future runs.

However, while individual years with no inundation, which may represent dryer than normal water level conditions, do still have organic accretion, so do years when inundation is negative. Zero values occur when the mean annual water level is the same as the marsh elevation, and negative inundation means that the mean annual water level is below the level of the marsh surface. For some pixels identified in the test runs inundation can be negative for a number of years (Figure 48). For each of the points shown in Table 4 for G030, every year before the year with zero inundation had negative inundation. Negative values for mean annual inundation does not mean the marsh was not flooded at any time during the year. Mineral sediment deposition can only occur if the marsh is flooded at some point during the year. For some of these example sites there are extensive periods with negative mean annual inundation and zero sediment deposition (i.e., an indication of no flooding) with organic accumulation continuing. For example, TR_03, site 2 would have 20 years at 0.55 cm/yr of organic accretion (corrected values) with essentially no marsh flooding. For TR_13, site 2, mineral deposition indicates that the pixel was flooding for some time even though mean annual inundation is negative through Year 47.

In the 2012 morphology model and in the 2017 ICM, organic accretion was calculated based on mineral sediment deposition. Sediment deposition rates were assigned bulk density and organic matter values based upon the vegetation type present, and an annual vertical accretion rate was calculated and used to update the marsh elevation. Thus if there was no sediment deposition there was also no accretion. The update to allow accretion to occur in non-flooded wetlands was designed to ensure that organic accretion was not dependent on sediment deposition. It was not intended to allow organic accretion to continue to occur year after year in areas with no flooding.

Changes need to be made based on this test to ensure that organic accretion is not occurring for extended periods when there is no marsh flooding. The ICM can only track surface waters. In coastal wetlands, it is possible that soils could stay saturated and support wetland vegetation without surface flooding. It seems logical that organic matter accretion would decline in areas that are not flooded, not because the plants would stop producing organic matter, but because organic matter would decompose much faster in an aerated soil. The ICM should limit organic matter accretion in pixels that have an elevation above the maximum daily mean water level (i.e., that are not flooded at any time during the year) to zero. Note that if a wetland does not accrete in any one year due to this condition, subsidence will reduce elevation and sea-level rise will increase water levels and so the lack of organic accretion is unlikely to persist for extended periods.

Table 5 shows results for organic vertical accretion rates for G030. The delta plain values reflect those in the revised OMAR lookup table. There appears to be an error in the code regarding the OMAR lookup table value for Chenier Plain brackish marshes. The model output indicates 0.048 g cm^{-2} yr^{-1}. It should be 0.042. We were unable to find output for a fresh marsh in the Chenier Plain. Chenier Plain intermediate and saline marsh organic accretion values adhere to the OMAR rates in the revised lookup table.

Table 5. Organic vertical accretion rates (cm yr^{-1}) by marsh type and geomorphic setting (Chenier Plain vs. Delta Plain) for G030

	Chenier Plain	**Delta Plain**
Fresh	*	1.17
Intermediate	0.53	1.00
Brackish	0.63**	0.86
Saline	0.50	1.08

* Unable to find output for this geomorphic/marsh type combination to verify the rate.

** An OMAR value of O.48 was mistakenly applied for brackish marshes in the Chenier Plain for G031 (which, when divided by K1, gives 0.63 cm/yr for accretion). The correct value is 0.42, which gives an organic accretion rate of 0.55 cm/yr. This mistake has been corrected in the lookup table used by ICM-Morph for future runs.

Less difference in accretion between vegetation types for G031 was observed compared to G030. Investigation of CRMS0132, which fluctuates between marsh classifications over the course of both 50-year model runs, clearly shows that temporal variability in organic accretion rates associated with temporal variability in FFIBS score is reduced for G031, and that the values of organic accretion rates for G031 are in between the values for the habitat type classifications that envelop the FFIBS score. For example, in CRMS0132 (Figure 50, red line), the site is classified as brackish for the first six years and then intermediate for the remainder of the model run. The FFIBS score of that site is in between intermediate and brackish. Under G030 (Figure 50, blue line), the organic accretion rate is 0.85 cm yr^{-1} while it is classified as brackish, and then instantaneously increases to 1.00 cm yr^{-1} when the FFIBS score crosses the threshold for the site to be classified as intermediate. G031, on the other hand, outputs organic accretion rates that temporally fluctuate with the FFIBS score, and in general the values generated by G031 fall in between the more categorical values generated by G030, with discontinuities due to marsh classification changes dampened.

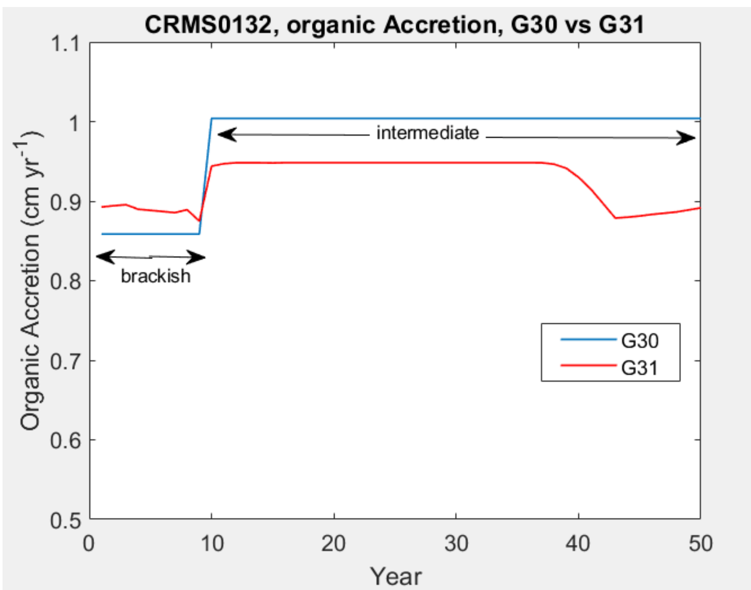
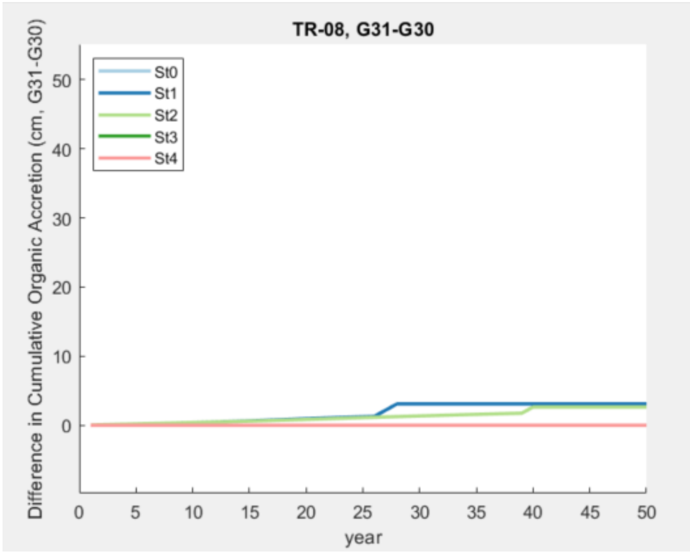
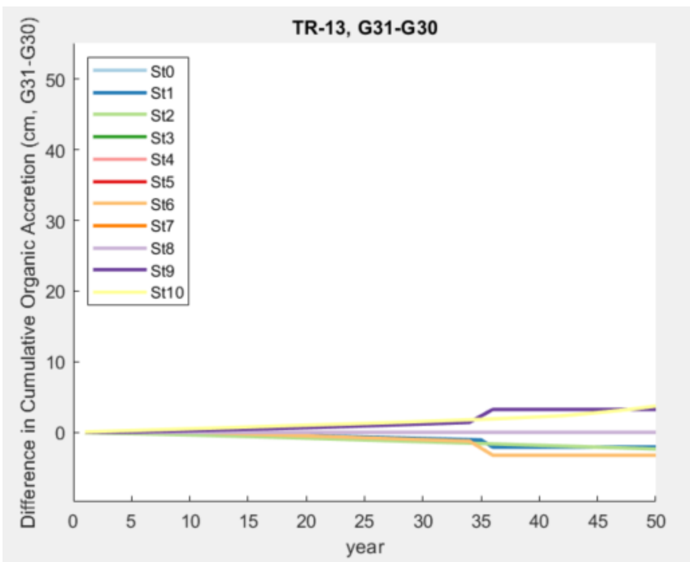


Figure 50. Organic Accretion over time at CRMS0132 for G030 (blue line) and G031 (red line).

The effect of using the G031 approach compared to G030 was evaluated by calculating the difference between G031 and G030 for cumulative organic accretion over the 50-year model run for transects TR_08, TR_03, and TR_13 (Figure 51 – Figure 53 and Table 6). At two sites along transect TR_08 (Chenier Plain near Freshwater Bayou) the cumulative difference in total organic matter accretion between the two test runs tended to be about 3 cm over the 50 years. For transect TR_03 (lower Terrebonne), the difference in organic matter accretion between the two model test runs indicated a range from -2.09 to +3.72 cm over 50 years at various sites along the transect.


TR-08, G31-G30
Difference in Cumulative Organic Accretion (cm, G31-G30)
St0
St1
St2
St3
St4
year


TR-13, G31-G30
Difference in Cumulative Organic Accretion (cm, G31-G30)
St0
St1
St2
St3
St4
St5
St6
St7
St8
St9
St10
year

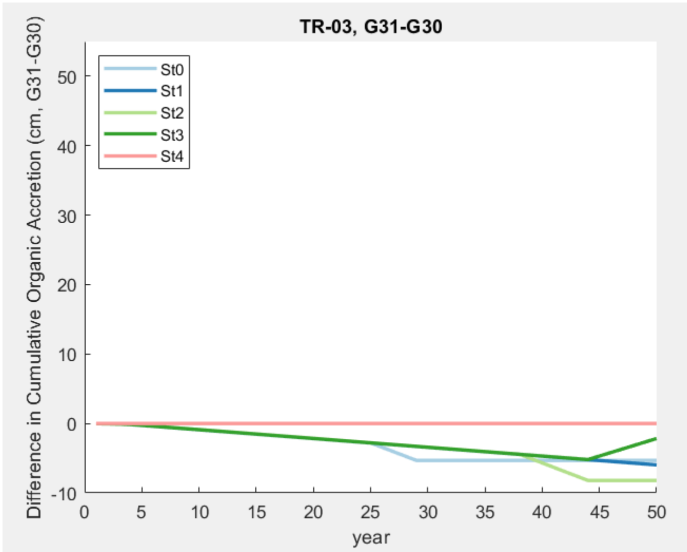


Figure 51. Difference in cumulative organic accretion for G030 and G031 at Transect 8 sites (top), Transect 13 sites (middle), and Transect 3 sites (bottom).

Table 6. Cumulative Organic Accretion for G040 and G031 and the difference for Transects 8, 13, and 3 (cm)

TRANSECT/SITE*	CUMULATIVE ORGANIC ACCRETION, G030 (CM)	CUMULATIVE ORGANIC ACCRETION, G031 (CM)	DIFFERENCE IN CUMULATIVE ORGANIC ACCRETION, G031-G030 (CM)
TR08_01	22.24	25.32	+3.08
TR08_02	33.36	35.99	+2.64
TR13_01	33.00	30.91	-2.09
TR13_02	50.00	47.62	-2.37
TR13_06	31.28	28.03	-3.25
TR13_09	25.66	28.89	+3.23
TR13_10	42.77	46.48	+3.72
TR03_00	18.32	13.00	-5.32
TR03_01	31.58	25.62	-5.96

TRANSECT/SITE*	CUMULATIVE ORGANIC ACCRETION, G030 (CM)	CUMULATIVE ORGANIC ACCRETION, G031 (CM)	DIFFERENCE IN CUMULATIVE ORGANIC ACCRETION, G031-G030 (CM)
TR03_02	27.79	19.59	-8.20
TR03_03	27.79	25.62	-2.16
TR03_04	25.00	25.00	0

* TR08_00, TR08_03, TR08_04, TR13_00, TR13_03, TR13_04, TR13_05, TR13-07, and TR13-08 are not included here since the pixels are all water and show no accretion.

In general, differences in organic accretion between the test runs are likely to be higher in the Delta Plain as the differences in values for OMAR between the vegetation types is greater, and so the interpolation between the 'steps' is steeper (Figure 51). To confirm this, annual organic accretion rates were compared for locations along Transect 13. At site 1, which is intermediate marsh throughout, there is little difference between G030 and G031 (Figure 52, top). Organic accretion is slightly lower in G030 due to the interpolation, and the pixel switched to open water a year earlier as the lower accretion reduced elevation and thus increased inundation depth. At site 6 there is a change in marsh type from brackish to intermediate and back to brackish in the last decade, and the change from brackish to intermediate is marked by an increase in organic accretion around Year 9 (Figure 52, bottom). G031 has lower organic accretion and the pixel is lost to open water two years earlier than in G030. The switch back to brackish in that area is not shown as the pixel has already converted to open water.

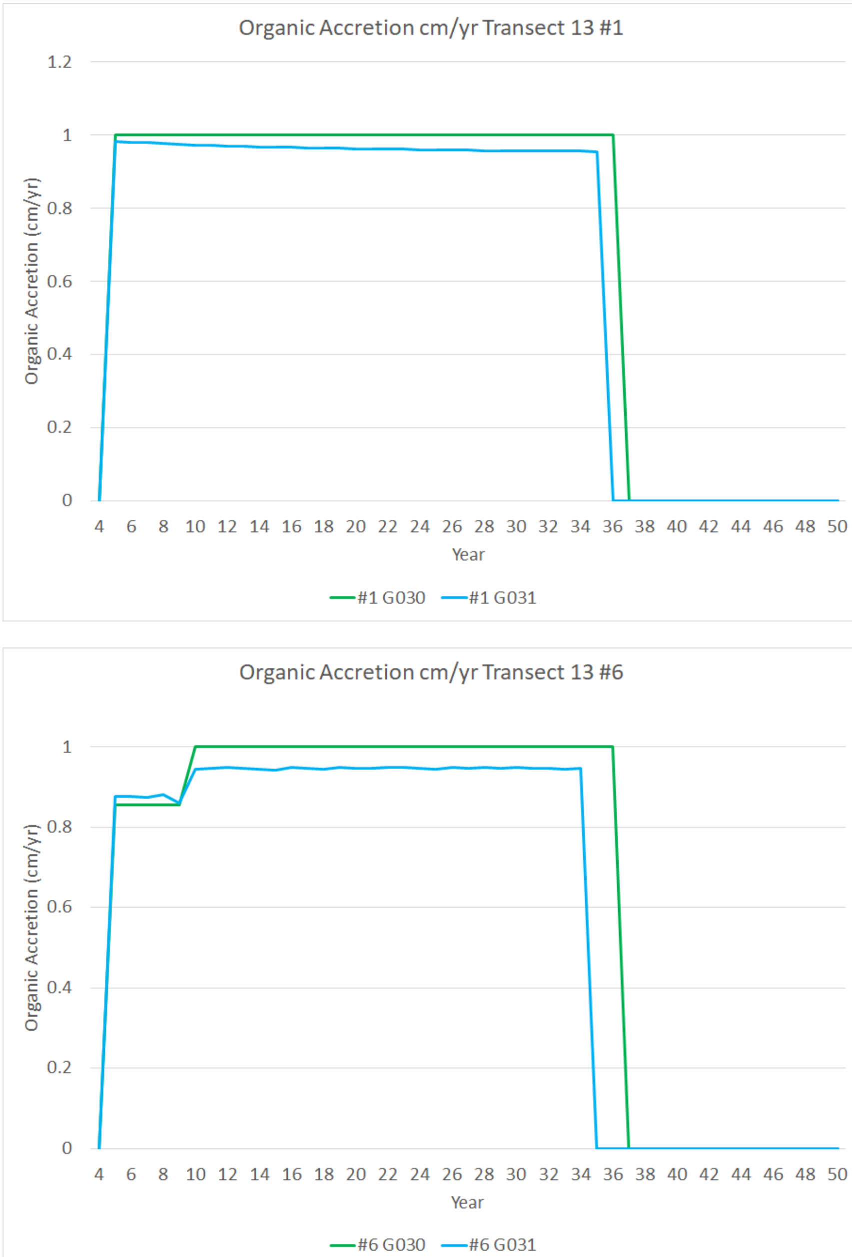
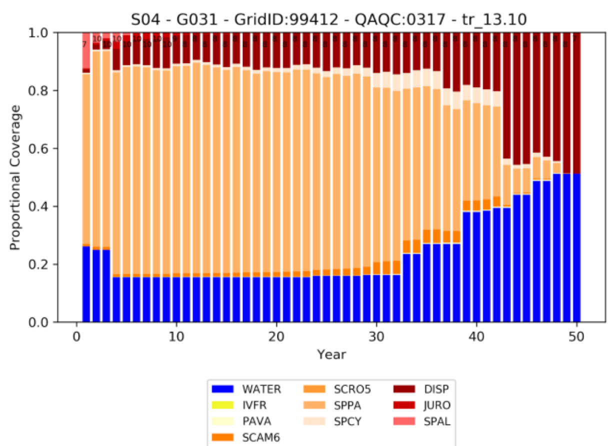


Figure 52. Organic Accretion (cm/yr) for Transect 13, site 1 (top) and site 6 (bottom).

At site 10, the effects of vegetation transition on organic accretion can be seen in the later years of the simulation. Vegetation changes at this site from brackish to more saline species in later years, leading to a gradual increase in organic accretion (Figure 53). The saline species (DISP) has a FFIBS score of 17.5, so even though there is a switch in species, the cell is still classified as brackish based on FFIBS score. Thus, organic accretion is constant for G030, but for G031, it gradually increases as DISP becomes more dominant because the interpolation reaches a maximum OMAR value at a FFIBS score of 18.



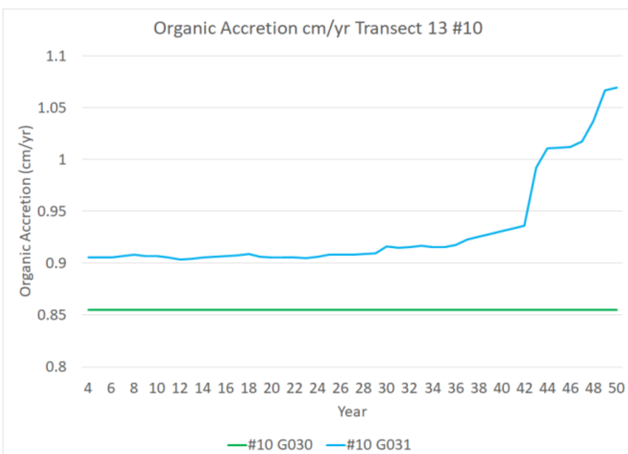


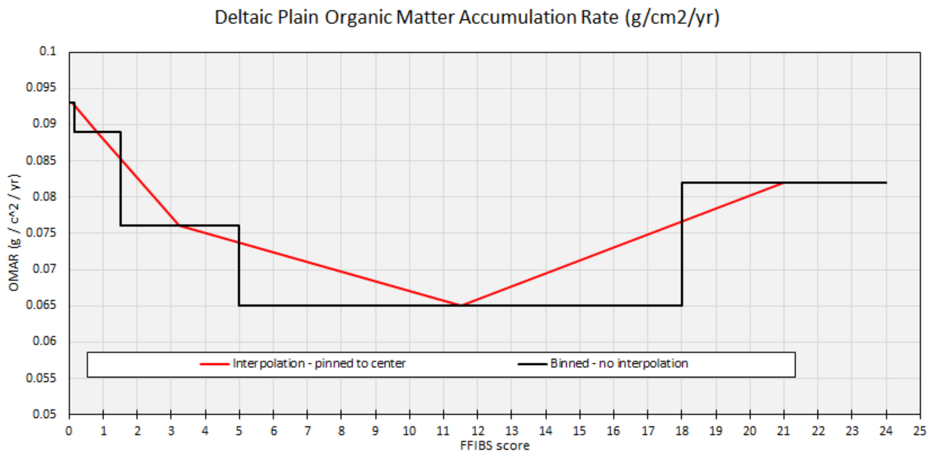
Figure 53. Vegetation coverage over time for G031 (left) and Organic Accretion (cm yr^{-1}) over time for G030 and G031 (right) at Transect 13, site 10.

2.4 RECOMMENDATIONS

- Adjust organic accretion to only occur in marshes with an elevation below the maximum daily mean water level experienced in that year. If the marsh elevation is above the maximum daily mean water level, organic accretion should be zero in that year.
- Due to issues with mineral deposition in these runs, related results (e.g., total

accretion) could not be evaluated with confidence. Further testing is needed to look more carefully at accretion and land change patterns. Specific issues that need to be examined include:

    - Total accretion - given high rates of organic accretion in G030 and G031 for saline marshes and forested wetlands (even after the adjustment based on stage), are total accretion rates reasonable once the mineral component is dynamically included in the model?
    - Vegetation establishment on new land – are patterns of land gain in newly building areas reasonable based on the bed elevation change in un-vegetated area.
    - Note that after the test runs, caps were added on mineral deposition in ICM-Morph such that mineral accretion was limited to:
        - No higher than subaerial line (max water level for month), and a
        - Total vertical limit 10 cm/yr applied to total annual value.
- Review full ICM runs to evaluate hypotheses not addressed with these test runs:
    - Tracking of upland (not mod) that might transition to wetland based on inundation
    - Loss of fresh marshes due to high water conditions persisting for two years in a row (due to the "blue line" threshold)
- Further examine and address expansion of attached marsh into areas previously occupied by flotant.
    - Adjustments made after the test runs to fix elevation and potential grid issues should have fixed this issue, but this should be confirmed.
    - Loss of flotant should result in water too deep for vegetation establishment/survival. Note that this could be related to issues with accretion rates in these runs – accretion from ICM-Morph maybe increasing elevation in the open water areas too rapidly – so may not be an issue in future runs with the fully updated ICM.
- Adjust interpolated OMAR value approach tested in G031 to pin values at the midpoint of the range rather than the low end (Figure 54).
    - Allows variation in OMAR over the range of FFIBS scores within the saline cover category, and alleviates the Delta Plain issue that all brackish marshes with greater than a minimum FFIBS score have higher than brackish OMAR values.



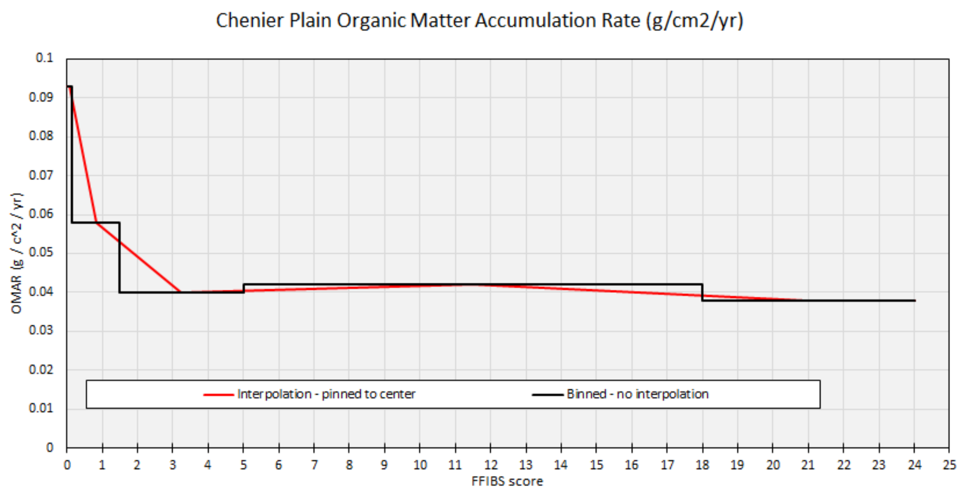


Figure 54. Interpolated Organic Matter Accumulation Rate (g/cm^2/yr) for Deltaic Plain (top) and Chenier Plain (bottom).

Other updates to be incorporated for future runs:

- Update existing conditions veg map reflecting the distinction between PAHE2 and PAHE2_flt
- Changes to classification of upland forest species from the existing conditions map in LAVegMod
    - Change infrequently flooded forest to oak
    - Change spoilbank areas to bareground
- Changes in the ICM-LAVegMod grid to align with the ICM-Morph grid, including removal of poldered areas
    - also reclassified bare land in developed areas upland of poldered areas to

not mod

- Add a minimum allowable coverage of 1 m^2 for species to be considered ‘present’
- Finalize approach for spatially differentiating active delta areas for production runs, including for areas where new deltas are expected (i.e., diversion outfall areas).
    - Identify active deltas in the model using two criteria: the ICM-Hydro compartment must be flagged as a potential active deltaic location, and the modeled FFIBS score must be less than 3.0 (to capture fresh marsh as well as intermediate species such as Roseau cane and cattail that are commonly found in deltas).