Biological Evaluation of the Renewable Fuel Standard (RFS) Set 2 Rule

United States
Environmental Protection
Agency

Biological Evaluation of the Renewable Fuel Standard (RFS) Set 2 Rule

U.S. Environmental Protection Agency
Office of Air and Radiation
Office of Transportation and Air Quality

United States Environmental Protection Agency

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List of Acronyms and Abbreviations

Numerous acronyms and abbreviations are included in this document. The most commonly used ones are defined below.

BBD	Biomass-Based Diesel, which includes biodiesel and non-ester renewable diesel qualifying as advanced biofuel under the RFS program
BE	Biological Evaluation
CAA	Clean Air Act
CNG	Compressed Natural Gas
CONUS	Contiguous United States
CRP	Conservation Reserve Program
DOE	U.S. Department of Energy
DPS	Designated Population Segments
EISA	Energy Independence and Security Act of 2007
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 2005
ESA	Endangered Species Act
ESU	Evolutionary Significant Units
FASOM	Forest and Agricultural Sector Optimization Model
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FFDCA	Federal Food, Drug, and Cosmetic Act
FWS	Fish and Wildlife Service, U.S. Department of the Interior
GCAM	Global Change Analysis Model
GHG	Greenhouse Gas
GIS	Geographic Information System
GLOBIOM	Global Biosphere Management Model
GTAP-BIO	Global Trade Analysis Project - Biofuels
LCA	Lifecycle Analysis
LCFS	Low Carbon Fuel Standard
LNG	Liquified Natural Gas
NLA	National Lakes Assessment
NMFS	National Marine Fisheries Service, National Oceanic and Atmospheric Administration
NRSA	National Rivers and Streams Assessment
PBFs	Physical and Biological features (PBFs)
PCEs	Primary Constituent Elements (PCEs)
RtC3	Biofuels and Environment: Third Triennial Report to Congress
RFS	Renewable Fuel Standard
RIA	Regulatory Impact Analysis
RIN	Renewable Identification Number
RNG	Renewable Natural Gas
RPAs	Reasonable and prudent alternatives
RVO	Renewable Volume Obligation
SWAT	Soil and Water Assessment Tool
WRTDS	Weighted Regressions on Time, Discharge, and Season

I. Executive Summary

The Endangered Species Act requires federal agencies to consult with the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) (hereafter "the Services") whenever the agency determines that a discretionary federal action may affect endangered or threatened species or designated critical habitat. The U.S. Environmental Protection Agency (EPA) has made such a determination for the Renewable Fuel Standard (RFS) rulemaking titled, “Renewable Fuel Standard (RFS) Program: Standards for 2026–2027, Partial Waiver of 2025 Cellulosic Biofuel Volume Requirement, and Other Changes.” A proposal for this rulemaking, also known as the “Set 2 Rule,” was published on June 17, 2025 (US EPA, 2025b) and proposes RFS volume requirements and associated percentage standards for the years 2026 and 2027 as well as a series of important modifications to strengthen the RFS program. A supplemental proposal was published on September 18, 2025. The supplemental proposal provided additional information and proposed changes to the volumes and percentage standards in light of decisions on small refinery exemptions issued in August 2025. We are preparing to finalize this action, with some modifications from the proposals.

In this Biological Evaluation (BE), we first provide a chronology of our interactions with the Services towards completing ESA consultation on the Set 2 Rule, followed by an overview of the RFS program. We then describe in more detail the RFS Set 2 Rule as well as the action area, defined by 50 CFR § 402.02 as the area within the U.S. that will be affected directly or indirectly by the Set Rule. The EPA has determined that the production of crop-based feedstocks has the potential to affect endangered and threatened species (also referred to as “listed species” in this document) and critical habitat by contributing to land use changes that could, for example, lead to habitat loss or water quality impairments via runoff from agricultural lands. We are therefore engaging in an ESA section 7 consultation with the Services. The action area we delineate is based on where crops of corn, soybean, and canola are currently grown in the U.S. and where we project that land use changes may occur, as well as the associated downstream areas that could be impacted by agricultural runoff and pollution from such crop areas. We focused our analyses on these three crops because they are used to produce the bulk of renewable fuel under the RFS: corn ethanol; soy biodiesel and renewable diesel; and canola biodiesel and renewable diesel.[1] The EPA found that the Set 2 Rule action area likely overlaps with a total of 731 unique species: 699 FWS species, 40 NMFS species, and 8 that are both FWS and NMFS species. And because multiple species have Designated Population Segments (DPSs) or Evolutionary Significant Units (ESUs), a total of 821 populations are evaluated in this BE. The full list of species and populations can be found in Section V.

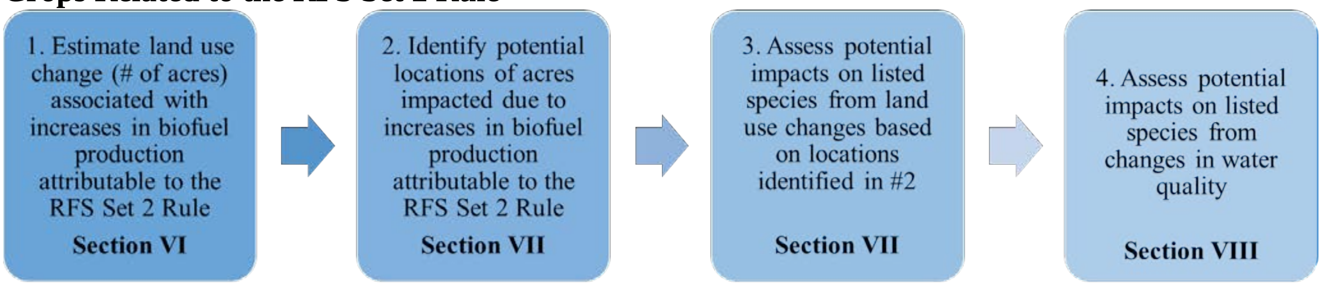
To further assess how the Set 2 Rule may affect these species, we followed a four-step process to assess potential impacts, as depicted in Figure ES-1.[2] We used the same general approach to estimating the impact for the Set 2 Rule on listed species as in our BE for the Set 1

[1] Hereinafter, references to “soy biodiesel” and “canola biodiesel” will encompass both biodiesel and renewable diesel.

[2] This process diagram is a general description of how we approached the analyses. In the context of the discussion of potential changes in corn, soybean, and canola production we have provided process diagrams that are specific to each of these feedstocks.

Rule,[3] however we have updated and improved some of the methodologies used to estimate the land use change associated with increases in biofuel production attributable to the RFS Set 2 Rule (Step 1).

Figure ES-1: Illustration of the EPA's Four-Step Process to Assess Potential Impacts on Threatened and Endangered Species Due to Increases in Each of the Three Feedstock Crops Related to the RFS Set 2 Rule



Note: The sections of this Biological Evaluation that discuss each step are indicated in bold in the figure.

Step 1. Estimate land use change impacts attributable to the RFS Set 2 Rule

There are many factors, including various economic and policy drivers, that influence the production of renewable fuels in the United States. In Section VI.A, for example, we discuss how the increases in historical corn ethanol production were driven by a wide range of factors in addition to the RFS Program.[4] As Step 1 for this BE, we made an attempt at estimating the land use changes associated with increases in the production of corn ethanol, soybean biodiesel, and canola biodiesel that could be attributable to the Set 2 Rule. We estimated the increase in total cropland in the U.S. from 2026–2027 triggered by the increase in demand for corn, soybeans, and canola.

To assess land use change impacts from corn ethanol and soybean biodiesel, we leveraged analyses available in published literature combined with updated data to estimate the change in corn acres, soy acres, and total cropland per billion gallons of corn ethanol and soy biodiesel production. Finally, for canola biodiesel, we relied on modeling work from a previous RFS rulemaking that approved a new canola renewable diesel pathway. The results are shown in Table ES-1.

[3] Biological Evaluation of the Renewable Fuel Standard Set Rule and Addendum, EPA-420-R-23-029, May 2023.
[4] Though this document in some cases looks at historical trends—for example, historical drivers of ethanol use—this BE assesses only potential future impacts of the Set 2 Rule proposed volumes.
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Table ES-1: Potential Acreage Impacts for All Crops in the U.S. Due to Increases in Corn Ethanol, Soybean Biodiesel, and Canola Biodiesel That Can Be Attributed to the EPA's Set 2 Rule

	Volume Increase in RFS Set Rule (billion gallons)		Potential Acreage Increase All Crops (million acres)	
	2026	**2027**	**2026**	**2027**
Corn ethanol	0.212	0.228	0.094	0.101
Soybean biodiesel	2.433	2.705	2.335	2.596
Canola biodiesel	0.911	0.908	0.278	0.276

The potential acreage impacts by 2027 (Table ES-1), in addition to an estimated 0.725 million acres of indirect total cropland impacts (described in further detail in Section IV), indicate that the RFS Set 2 Rule could potentially lead to an increase of as much as 3.698 million acres of cropland by 2027. These estimates are based off the proposed Set 2 Rule volumes and are larger than the estimated potential acreage impacts attributed to the final volumes, as shown in Table IV.A.2-2 and discussed in further detail in Section IV.

The need for multiple assumptions underlying this assessment, as well as the inherent uncertainty contributed to our finding of Not Likely to Adversely Affect (NLAA) listed species and critical habitat. For example, projecting the impact of increased biofuel demand on corn, soybean, and canola production is complicated by the fact that the majority of all three crops is used in non-biofuel markets.[5] There is thus uncertainty in attributing the increased biofuel demand from the Set 2 Rule to corn, soybean, and canola planting decisions. Further, the potential impacts of any RFS volume standards on species would be indirect and mediated through markets. The fact that farmers do not generally grow crops for specific end uses (e.g., earmarked for biofuel production vs. animal feed), and the fact that biofuel producers do not specify how much of the fuel they produce is attributable to the RFS rather than what they would have produced in the absence of the RFS program, make our projections of the potential impacts of the RFS program on species inherently uncertain. Without reliable data on these points, we cannot identify with any specificity parcels of land that may be converted to cropland, or any changes in water quality that may result from such conversion, that could be the result of the incremental demand for biofuels created solely by the RFS program. Thus, the impacts presented in this BE are somewhat hypothetical and are based on potential scenarios, which often conservatively compensate for the absence of specific land conversion and associated water quality impact data. Where present in our analyses, we detail the uncertainty associated with the various inputs and interpretations of our projections.

The uncertainties in the relationship between increased demand for biofuels and crop acreage are further discussed in the EPA's Third Triennial Report to Congress (RtC3) (US EPA, 2025b) at sections 6 and 7. We are unable to quantify a discrete contribution of the RFS to increased crop-based feedstock production, as any of these increases could be a result of other factors, like increased yields and crop production for other non-biofuel uses. The discussion of estimates in this and later sections are therefore uncertain given the lengthy causal chain between the EPA setting the volume requirements under the RFS program, and any potential impacts on listed species and critical habitat. Any break in the causal chain would mean that the RFS Set 2 rule did not cause the outcome contemplated by our analysis.

Our soybean biodiesel analyses provide an example of this uncertainty: out of the three feedstock categories, increases in soybean biodiesel from the RFS Set 2 Rule proposed volumes are expected to have the greatest acreage impacts at an estimated 2.59 million acres of soybeans, which is ~2.22 million acres greater than the estimated acreage impacts from corn ethanol and canola biodiesel combined (Table ES-1). Importantly, however, our analyses suggest that the expected increased demand for these types of biofuels attributable to the Set 2 Rule could be met without the need for additional soybean production in the U.S. The increase in the attributable volume could be met, for example, by increased imports of BBD and/or feedstocks to produce BBD, decreased BBD exports, increased soybean yields, the diversion of soybean oil from other markets, or some combination of these changes.

Step 2. Identify locations potentially impacted by increases in acres from the Set 2 Rule

After estimating the potential acreage impacts attributable to the Set 2 rule, we next projected where these acreage changes would occur. It is highly challenging to state with a high degree of confidence *where* such acreage increases might occur in the United States given the vast quantity of potential cropland in the U.S. and the multitude of factors that contribute to an individual farmer's decision whether to bring additional land into crop production. Even so, in order to conduct this BE, it was necessary for us to attempt to identify locations to better understand potential impacts of the Set 2 Rule on listed species and critical habitat.

Faced with this high level of uncertainty, we developed a probabilistic approach to select available lands for potential conversion within the action area. We defined four land cover classes as areas that could be converted to cropland: (1) shrubland, (2) grassland/herbaceous, (3) pasture/hay, and (4) emergent herbaceous wetlands. We used ArcGIS Pro and R[6] to randomly simulate conversion of about 3.764 million acres of land.[7] We repeated the process 500 times[8] to generate an estimated probability that given acre of land would be converted to growing additional corn and soybeans for the specific purpose of producing renewable fuel.

These locations of potential land use change do not identify actual conversion as a result of the RFS Set 2 Rule but rather provide the EPA with a tool to identify areas of potential impact.

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[6] ArcGIS is a geographic information system software commonly used for mapping and spatial analyses. R is software commonly used for statistical computing and graphics.

[7] The amount of land simulated to be converted (3.764 million acres) is slightly different from the land estimated to be converted (3.69 million acres). This occurred because the simulations, which were based on draft estimates, are computationally very time consuming and there was not time to rerun for the final numbers. The draft numbers, however, are only 2% higher, thus are a reasonable and slightly conservative estimate.

[8] We ran 500 iterations for all cases except one (range of FWS species). The computational time was too slow due to the large number of FWS species and large ranges, so we reduced that simulation to 100 iterations (see Section VII).

Step 3. Identify potential impacts on listed species from land use changes

The EPA's analysis of the potential impacts on listed species is based on predicting what quantities of land use change might occur and where those land use changes might manifest because of the Set 2 Rule. This is because changes in the way that land is used could impact listed species in several ways: non-cropland that is converted to cropland could result in adverse effects to the habitats or ranges of listed species; and nearby habitats could be indirectly affected by dust or runoff created during the land conversion. Similarly, in cases where additional crops are grown on existing cropland through various intensification measures such as double-cropping or increased fertilizer or pesticide use, there could be impacts on flora and fauna for that land and nearby areas. In evaluating potential impacts to species with critical habitat, it is especially important to assess whether effects would occur to essential Physical and Biological features (PBFs)[9] or Primary Constituent Elements (PCEs)[10] found within the boundary of the critical habitat.

Using the locations identified for potential land use change driven by demand for biofuels attributable to the Set 2 rule (Step 2), we identified which listed species or critical habitats are present in or near the locations subject to potential land use change. For the FWS species that had the greatest potential critical habitat impacts from land use changes alone, we found that up to 1.5 percent of their critical habitats could be potentially impacted (Table VII.B-1). In another scenario, when we added a 2,600-foot buffer to critical habitats, the top impacted species saw up to 1.4 or 37.2 percent of their critical habitats impacted depending on the calculation method used[11] (Table VII.B-1). Results also indicate that the top FWS species with ranges potentially impacted could have up to 1.6 percent of their range impacted, and when a buffer was included up to 1.3 or 9.6 percent of their range was impacted depending on the calculation method used (Table VII.B-1). After applying the same simulations to NMFS species, only one critical habitat plus buffer scenario resulted in impacts greater than 1 percent for species; in this scenario, the highest potential impact was 3 percent for one population (Table VII.D-1).

In total we identified 821 listed populations in the analyses. Of the 821 listed populations, we estimated that only 16 may have greater than 1% of their critical habitat converted to cropland (7 or 136 populations had greater than 1% of critical habitat impacted when a buffer was added, depending on the calculation method used) and 11 populations may have greater than 1% of their range converted (8 or 34 populations had greater than 1% of their range impacted when a buffer was included, depending on the calculation method used). It is possible that there may be no land use impacts at all to species/populations and their critical habitats due to the RFS Set 2 Rule volumes. For example,

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[9] Physical and Biological features (PBFs): The features that occur in specific areas and that are essential to support the life-history needs of the species, including but not limited to, water characteristics, soil type, geological features, sites, prey, vegetation, symbiotic species, or other features. (49 FR 38908)

[10] Primary Constituent Elements (PCEs): This term has largely been replaced by "Physical and Biological features" in newer regulations.

[11] There are two results for each of the simulations with the 2,600-foot buffer, as the percent of critical habitat or range impacted was calculated in two manners. For one calculation, we divided the converted acreage by the total area considered (i.e., critical habitat plus buffer). For the second calculation, we divided the converted acreage by only the critical habitat or range area for the species. Both approaches are reasonable but capture slightly different approaches to estimating impact. More information can be found in Section VII.

there would likely be no impact were the volumes to be met through other means such as increasing imports, decreasing exports of biofuels or feedstocks, or diverting feedstock from other non-biofuels use.

Step 4. Assess potential impacts on listed species from changes in water quality

To estimate the impact on water quality attributable to the Set 2 Rule, we leveraged results from a new historical nutrient trends analysis performed by the EPA for the Set 2 Rule to estimate the water quality impacts on a national scale from observed increases in cropland during the biofuel expansion period. This analysis is only intended to evaluate what could potentially be attributable to the Set 2 Rule based on historic trends and is not intended to be a retrospective analysis of the RFS program as a whole or of specific previous RFS rules. We paired this new analysis with the same results from published literature that used the Soil and Water Assessment Tool (SWAT) performed for the RtC3, which was used in the Set 1 Rule, to estimate specific water quality impacts from the time of increasing cropland expansion prior to 2021. While these analyses are not based on the land use change estimates from the Set 2 volumes, the historical trends and data they evaluate provide a broader picture of the potential water quality impacts we can expect from crop-based biofuel land use change as a whole.

The historical nutrient trend analysis is a broader analysis consisting of three separate, smaller analyses. The first uses the National Nutrient Inventory to study shifts in agricultural nutrient sources from 2002 to 2017, a period of increased agricultural production, partially due to the RFS program, during that general period. The second uses the National Lakes Assessment (NLA) and National Rivers and Streams Assessment (NRSA) databases to summarize nutrient conditions for surface waters from 2008 to 2022. The third uses geospatial cluster modeling to analyze trends in watershed export of sediment and total nitrogen and phosphorous. The results of these analyses show that, as expected, fertilizer inputs and crop nitrogen fixation have increased due to expansion of livestock production and corn and soy cultivation. However, crop removal of nitrogen and phosphorous has largely kept pace with or exceeded those increases. Additionally, although nutrient pollution is a widespread stressor for surface waters, nutrient concentrations for the analyzed time period were nationally relatively stable, with either no significant trends or significant decreases in waters in poor condition. Finally, the regional trend analysis shows that the most common trend is actually declining nutrient and sediment export, in general. Flow-normalized nutrient export remained relatively stable in the analyzed regions, although more research would need to be done to visualize results at larger watershed scales. In general, these results show that despite the increase in agricultural production in recent years, there is not significant national degradation in water quality attributable to that production, which can indicate how water quality will react to the land use change predicted as a result of the Set 2 Rule.

For the SWAT modeling analysis, we relied on a 2021 study that applied the SWAT to the Missouri River basin to estimate the water quality changes resulting from land use changes observed from 2008–2016 (Chen et al., 2021) that was used for the RtC3 and the Set 1 BE. The total quantity of land converted to cropland in the Missouri River basin during this time period was approximately 2.51 million acres, which was similar to the total maximum land conversion we were expecting from the Set 1 Rule (compare Table ES.1 and Table VIII.A-1). Results showed that, at the outlet of the Missouri River, the conversion of non-cropland to cropland could result in an increase in the total nitrogen (TN) and total phosphorus (TP) loads of up to 6.4% and 8.7%, respectively. The modeled increases in total nitrogen and phosphorus would represent increases of approximately 0.8% and 2.1% respectively at the Mississippi River outlet.

Neither of the water quality analyses considered the impact of increased use of pesticides, and no equivalent study on pesticide concentrations exists. While nitrogen, phosphorus, and suspended solids are not perfect analogs to the pesticides, they do share some important similarities. The application rates for both fertilizers (nitrogen and phosphorus) and pesticides are expected to be related to the projected potential changes in cropland. For example, we expect that any new land planted in corn would be treated with fertilizers and pesticides at the average national rate for all corn acres. Total fertilizer and pesticide use would therefore depend on the amount of fertilizer and pesticides used to produce the new crop relative to the previous use of the land (whether cropland or non-cropland) and the total projected land use changes. We therefore estimate that the increase in pesticides in aquatic environments would be approximately equal to the increases in nitrogen and phosphorus projected in the Chen study using SWAT.

These analyses suggest that, even if the maximum projected acreage impacts from the Set 2 Rule (3.69 million acres total based on proposed volumes) were to occur, the water quality impacts will be small relative to total nutrient, sediment, and pesticide effects already happening at the mouth of the Mississippi and other larger water bodies within the action area. Also, effects are unlikely to negatively impact the NMFS species found within coastal regions and oceans, as the potential effects are insignificant relative to current conditions or are discountable (e.g., through diffusion of pollution before it reaches the areas of these species). Localized water quality impacts in freshwater ecosystems within the action area are also likely to be discountable as it is unlikely that species will be exposed to potential effects from the action caused by land use changes. EPA completed a qualitative analysis for some NMFS species in Section XI of this BE and this analysis supports this conclusion.

Finally, we note that the EPA currently has several programs and funding opportunities designed to improve water quality. We therefore expect that these efforts, discussed further in Section VIII.B, will help to lessen any potential water quality impacts of increased cropland attributable to the Set 2 Rule, if indeed such cropland increases come to pass.

NLAA Conclusion

The EPA's analyses support a determination that the Set 2 Rule may affect but is NLAA any of the 821 populations within the Set 2 Rule action area or their critical habitat. Specific species determinations are discussed in Section IX after considering life history and PBF information by taxonomic groupings. Even if there could be impacts to certain PBFs/PCEs, we cannot say with reasonable certainty that any particular species will be impacted, again due to the numerous layers of uncertainty between the finalized RFS Set 2 Rule volumes and on-the-ground, localized land use changes. Nevertheless, we find that while this action may affect listed species and critical habitat, we find that effects on all species and critical habitat are discountable (i.e., extremely unlikely to occur) and/or insignificant and thus are not likely to adversely affect listed species and critical habitat. With the submission of this BE, the EPA respectfully requests the Services' concurrence on the EPA's effects determinations for the species and critical habitat detailed in Sections IX.B and C that are not likely to be adversely affected by this federal action.

II. Consultation to Date

The following chronology summarizes the EPA's engagement with the Services in support of this ESA section 7(a) consultation.

- May 20, 2024 – Email from the EPA to the Services to share initial intent to develop a BE for the Set 2 Rule and confirm point of contacts at the Services, as well as process for seeking Services' input.
- May 20, 2024 – Email from Services to the EPA confirming point of contacts and process for input for the Set 2 BE.
- July 3, 2024 – Email from the EPA to the Services with attached presentation outlining broad plan for analytical plan and drafting of the BE.
- July 16 and 18, 2024 – Email from the FWS and NMFS confirming they have reviewed the EPA's presentation, are okay with the proposed approach and have no comments.
- Month of May, 2025 – Multiple emails between the EPA and the Services to confirm point of contacts at the Services and the EPA, provide the EPA's updates, ask for updated species lists from the Services, and reengage in technical assistance discussions for ESA consultation on the Set 2 rule.
- Months of July and August, 2025 – Multiple Emails between the EPA and the Services to schedule meetings.
- August 4 and 11, 2025 – Meetings with NMFS and FWS to discuss progress on BE and pieces they would like to see prior to consultation.
- August 28, 2025 – Email from the EPA to the Services with updated timelines for the Set 2 rule and expectations for consultation.
- Month of September, 2025 – Emails between the EPA and FWS to schedule meetings.
- October 1, 2025 to November 12, 2025 – Government shutdown.
- Month of November, 2025 – Emails between the EPA and the Services to reconnect after the government shutdown.
- December 1 and 4, 2025 – Meetings with NMFS and FWS to discuss progress on BE and updated timelines.
- December 15, 2025 – Email from EPA to the Services with new sections of the Set 2 Rule BE for review prior to official consultation.
- December 15, 2025 – Meeting between the EPA, FWS, and stakeholders to discuss general feedback on the Set 1 and Set 2 BEs.
- December 19, 2025 – Email from EPA to the Services with new sections of the Set 2 Rule BE for review prior to official consultation.
- January 8 and 14, 2026 – Meetings with NMFS and FWS to discuss draft BE prior to official request for concurrence.
- January 21, 2026 – Meeting with FWS to discuss approach for official request for concurrence for the Set 2 Rule BE.
- Month of January, 2026 – Emails between EPA and the Services discussing feedback and adjustments to technical analyses in the Set 2 Rule BE draft.

- January 30, 2026 – Meeting with NMFS to discuss technical aspects of the Set 2 Rule BE draft.
- February 9, 2026 – Meeting with FWS to discuss technical aspects of the Set 2 Rule BE draft.
- March 20, 2026 – Submission of revised draft of Biological Evaluation to Services with Request for Concurrence

III. The Renewable Fuel Standard (RFS)

Congress created the Renewable Fuel Standard (RFS) to reduce greenhouse gas emissions and enhance energy security through expanding the nation's use of renewable fuels. This program was created under the Energy Policy Act of 2005 (EPAct), which amended the Clean Air Act (CAA). The Energy Independence and Security Act of 2007 (EISA) further amended the CAA by expanding the RFS program. Under Clean Air Act section 211(*o*), the RFS program requires that certain minimum volumes of renewable fuel must be used in the transportation sector, for all years after 2005, with the goal of replacing or reducing the quantity of petroleum-based transportation fuel, heating oil, or jet fuel. 211(*o*) contains specific renewable fuel volume targets through 2022 and provides the EPA with the authority for setting volumes for 2023 and beyond. The statute also provides the EPA with the discretion to waive the volume requirements under specific circumstances. This section describes the operation of the RFS program, the conditions associated with the agency's available discretion, the historical production of renewable fuel, and factors affecting actual production and use of renewable fuel.

A. Statutory Requirements

The RFS program places an obligation on producers and importers of gasoline and diesel (hereafter simplified to "refiners") to utilize certain amounts of renewable fuel to replace fossil-based transportation fuels. The obligation is presented as a percentage standard that each refiner multiplies by its gasoline and diesel production and importation to determine the volume of renewable fuel for which it is responsible. The RFS program does not create an obligation for any individual party to produce or use any amount or type of renewable fuel. Instead, renewable fuel producers respond in typical market fashion to the demand for their products that is created by the RFS blending obligations placed upon refiners.

The applicable standards under the RFS program fall into four broad categories that are defined by the estimated greenhouse gas (GHG) benefits achieved by each renewable fuel relative to the petroleum-based fuels that they replace as well as some additional criteria. The statutory criteria for each category of renewable fuel in the RFS program are shown in Table III.A-1.

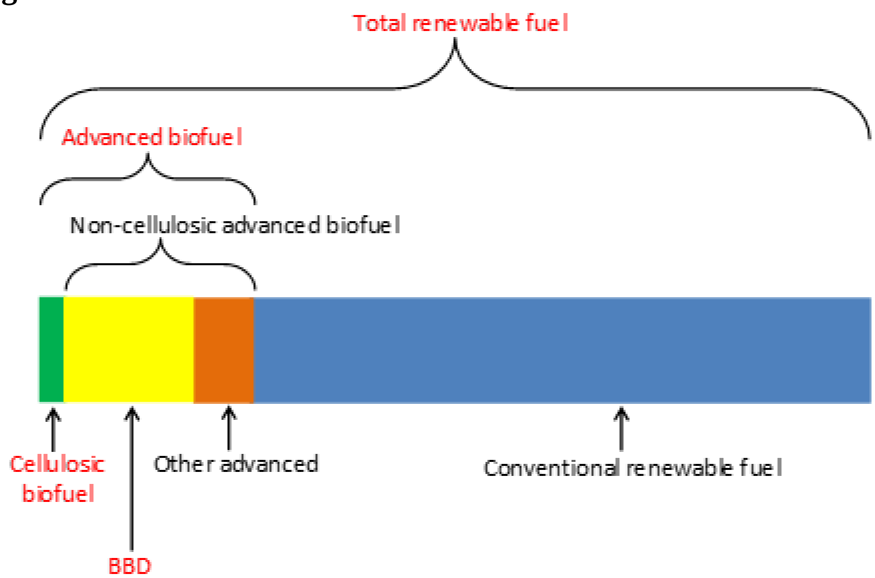
Table III.A-1: Statutory Criteria for Renewable Fuel Under the RFS Program

Category	Minimum GHG Reduction Requirement	Other Requirements and Exclusions
Cellulosic biofuel	60%	Must be made from cellulose, hemi-cellulose, or lignin
Biomass-based diesel	50%	Includes only biodiesel and renewable diesel, but excludes any renewable fuel that is produced through co-processing a feedstock with petroleum
Advanced biofuel	50%	Excludes ethanol derived from corn starch
Renewable fuel	20%[a]	Must be made from qualifying renewable biomass

[a] Does not apply to "grandfathered" renewable fuel produced in a facility that was operational or under construction before December 2007.

As defined under the statute, these four categories are nested within one another. For instance, both cellulosic biofuel and biomass-based diesel (BBD) also count as advanced biofuel, and all advanced biofuel count as renewable fuel. Since the nested nature of the categories necessarily means that there is some overlap between them, it is sometimes helpful to decompose the nested categories into mutually independent ones for discussion purposes. Thus, we may speak of non-cellulosic advanced biofuel rather than advanced biofuel and speak of conventional renewable fuel rather than renewable fuel. The relationship between all categories, both those defined in the statute and the decomposed categories having some additional practical utility, are shown in Figure III.A-1.

Figure III.A-1: Relationship Between Categories of Renewable Fuel Under the RFS Program

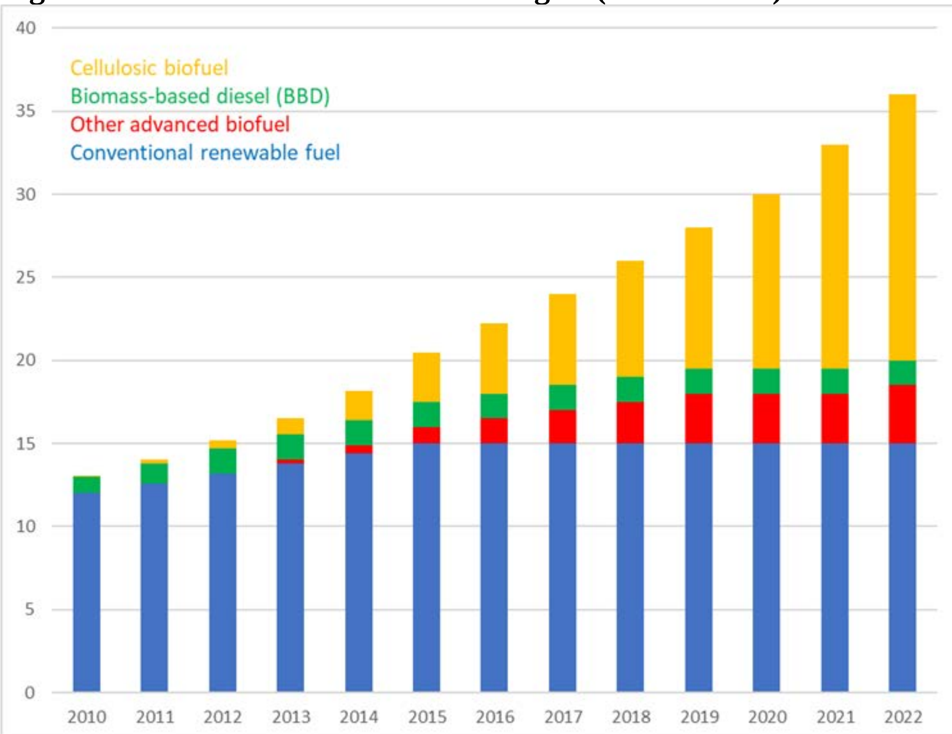


Note: Categories in red are those defined in the statute. Categories in black are sometimes helpful in differentiating between different renewable fuel types and their impacts.

Within the requirements and exclusions shown in Table III.A-1, the statute allows any renewable fuel made from any renewable biomass feedstock to qualify under the RFS program. Renewable biomass is defined in the statute. Thus, the applicable standards for each category do not require the production and consumption of any particular type of renewable fuel or the production of renewable fuel from any particular qualifying renewable biomass. The market's participants (refiners and importers of gasoline and diesel fuel, biofuel producers, fuel blenders, consumers, etc.) determine the mix of renewable fuel and feedstock types that end up being used as transportation fuel based on economic and other market factors in order to ensure that the RFS obligations are met.

The statute specifies volume targets for each of the four component categories of renewable fuel for years 2010 through 2022. These targets are shown below.

Figure III.A-2: EISA 2007 Volume Targets (billion RINs)



The statutory volume targets shown above represent the applicable volume requirements unless the EPA waives them in whole or in part as described in the next section. For years that the statute does not specify volume targets (i.e., 2013 and later for BBD and 2023 and later for all other categories), the EPA must establish the applicable volume targets following certain processes, criteria, and standards specified in the statute. The EPA implements the applicable volume requirements through percentage standards that obligated parties use to calculate their annual obligation.

Notably, the RFS program does not regulate the conduct of farmers who plant crops that can then be utilized as feedstock to create renewable fuel. In order to participate in the program, renewable fuel producers must register with the EPA and keep records demonstrating only that the renewable fuel meets the statutory requirements,[12] that the renewable fuel is produced from renewable biomass, and that the renewable fuel is used as transportation fuel in the United States. However, the program itself, and the standards promulgated in this action, do not require any action by or place any other requirements on any particular renewable fuel producer or farmer. The production of renewable fuels, their type, and the crop-based feedstocks used for many of them, like corn and soy, are not directly regulated by the RFS program. Instead, these many decisions and the resulting planting and crop marketing and sales decisions made by farmers are the result of many market factors such as crop prices, demand for crops, and local conditions, meaning that farmers' decisions regarding the best use of their crops can change from month to month and year to year.

[12] These statutory requirements do not include impacts on endangered species.

B. Discretion Under the Statute to Modify Volumes

The volumes in the CAA section 211(*o*)(2)(B) can be modified by the EPA in specified circumstances. CAA section 211(*o*)(7) provides the EPA's waiver authorities. CAA section 211(*o*)(7)(A) provides the EPA's "general waiver authorities," allowing EPA to waive the national quantity of renewable fuel in the statute in whole or in part upon a demonstration that the requirements would cause severe harm to the economy or environment of a State, region, or the United States, or a determination that there is an inadequate domestic supply. The EPA can only waive volumes under this provision after notice and opportunity for comment, and after consultation with USDA and DOE. The statute does not prescribe how the EPA is to determine the appropriate volume to waive.

The EPA has never waived volumes on the basis of "severe harm" to the economy or the environment under the general waiver authority. However, in December 2015 the EPA did waive volumes of total renewable fuel under a finding of "inadequate domestic supply." The EPA was challenged on that action, and after review the U.S. Court of Appeals for the D.C. Circuit ruled that the EPA had exceeded its authority in waiving volumes, holding that any waiver based on the "inadequate domestic supply" prong of 211(*o*)(7) would only be appropriate if there was an "inadequate domestic supply" of renewable fuel to obligated parties, and that the EPA could not consider demand side-factors, including the supply of renewable fuel to consumers.

The EPA has also received a number of administrative petitions requesting that we use our 211(*o*)(7) general waiver authority to reduce the RFS standard volumes, but to date the EPA has not granted any of these petitions. As recently as January 2021, the EPA sought comment on a number of petitions to waive the volumes under a finding of severe economic harm or a finding a severe environmental harm. In the notice, the EPA referred to its prior interpretation of the statutory provision, including that 1) the harm must be caused by implementation of the RFS program itself; 2) the harm must be fairly certain to occur and not be merely speculative; 3) the harm must be severe; 4) the harm must be to an entire state, region, or the U.S. and not to a single industry; and 5) given the discretionary nature of the waiver authority, the EPA will also consider benefits of the program. The EPA sought comment on the elements of that interpretation (*86 FR 5182*, 2021). The EPA reaffirmed that interpretation and denied the petitions for a waiver of the 2019 and 2020 RFS standards in a 2022 action (*87 FR 39600*, 2022; *87 FR 39620*, 2022).

CAA section 211(*o*)(7)(D) provides the EPA with additional waiver authority, commonly referred to as the "cellulosic waiver authority." Under this authority, the EPA shall reduce the volume of cellulosic biofuel when the projected volume of cellulosic biofuel production is less than the applicable volume of cellulosic biofuel. It also provides that the EPA *may* reduce the applicable volume of renewable fuel and advanced biofuel by the same or lesser volume. Courts have indicated that the EPA retains significant discretion in deciding whether to waive the advanced biofuel and total renewable fuel volumes, and by how much (*Americans for Clean Energy v. EPA*, 2017; *American Fuel & Petrochemical Mfrs. v. EPA*, 2019). The EPA has waived the cellulosic biofuel volume in 2010–2022. The EPA recently waived the 2024 cellulosic biofuel volume in a separate action (90 *FR* 29751, 2025) and is finalizing a reduction in the 2025 cellulosic biofuel volume using the same authority in this action.

Finally, CAA section 211(*o*)(7)(F) provides that the EPA shall modify the applicable volumes of renewable fuel if certain triggers are met. This is commonly referred to as the "reset authority." In doing so, the EPA is to analyze the same factors specified in CAA section 211(*o*)(2)(B)(ii). The EPA used this authority in a rulemaking published on July 1, 2022 to modify the 2020–2022 volume requirements for all fuel types except biomass-based diesel (*87 FR 39600*, 2022).

The EPA's waiver authorities, found in CAA section 211(*o*)(7), provide the EPA with the discretion to waive the volume requirements if certain criteria are met as described above. The EPA intends to use the set authority to establish the volume requirements for 2026 and 2027, and the cellulosic wavier authority to reduce the 2025 cellulosic biofuel volume requirement. Nevertheless, the EPA retains the ability to reconsider promulgated rulemakings. The EPA has, in the past, based on new information and drastically changed circumstances, revised standards after initially promulgating them using the waiver authorities.

We note that regardless of the authority that the EPA uses to establish nationwide volume requirements, the EPA can only set the overall applicable volumes of renewable fuel that are required to be used. Which types of fuels from which feedstocks and in what quantities ultimately are used are decisions made by program participants and the marketplace, a fact which makes it difficult to predict with any accuracy what each year's actual RFS fuel mix will be.

C. Historical Production of Renewable Fuel

The full list of renewable fuel types and feedstocks that qualify under the RFS is provided in Table 1 to Section 1426, part 80, Title 40 of the Code of Federal Regulations. In practice, however, certain renewable fuels have dominated the transportation fuels market while others have been used in very small quantities or not at all. The figure and tables below show the fuel types and feedstocks that were produced in the U.S. between 2016 and 2024 for cellulosic biofuel, non-cellulosic advanced biofuel, and conventional renewable fuel, along with the average contribution that each has made to the total volume over that timeframe (Figure III.C-1, Tables III.C-1 through 3). Also included is a table showing the average proportions for crop-based versus non-crop-based feedstocks produced domestically (Table III.C-4). Fuel types and feedstocks not shown were produced in only negligible quantities or not at all.

Figure III.C-1: Fuel Types That Were Produced in the U.S. From 2016–2024

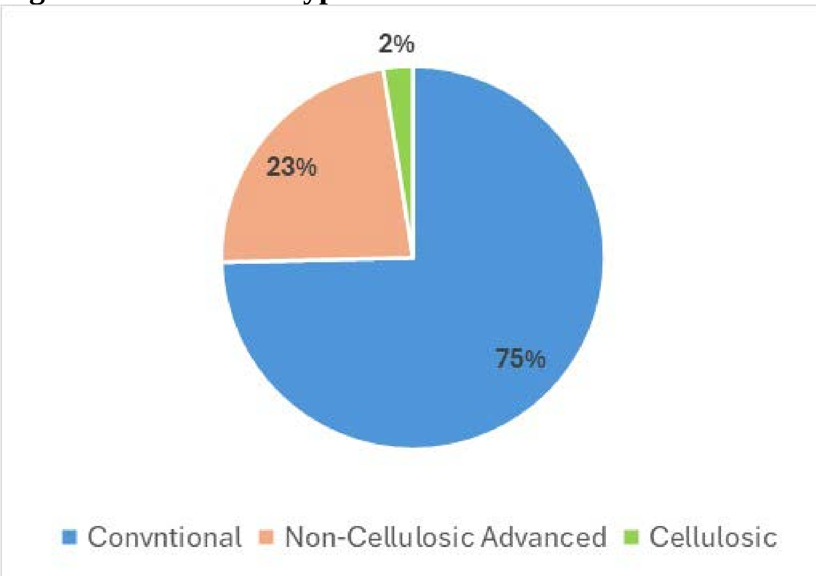


Table III.C-1: Fuel/Feedstock Combinations for Cellulosic Biofuel That Were Produced in the U.S. From 2016–2024

Fuel Type	Feedstock	Average Contribution to Total
CNG/LNG[a]	Landfill	80%
CNG/LNG	Agricultural digester	15%
CNG/LNG	Waste treatment plant	2.5%
Ethanol	Agricultural Residues	1.5%
CNG/LNG	All Others	0.4%
Ethanol	All Others	0.2%
Cellulosic Heating Oil and Diesel	All Feedstocks	0.2%

[a] CNG = compressed natural gas; LNG = liquified natural gas

Table III.C-2: Fuel/Feedstock Combinations for Non-Cellulosic Advanced Biofuel That Were Produced in the U.S. From 2016–2024

Fuel Type	Feedstock	Average Contribution to Total
Biodiesel	Soybean Oil	32%
Renewable diesel	Waste Oils/Fats/Greases	23%
Biodiesel	Waste Oils/Fats/Greases	12%
Renewable diesel	Soybean Oil	10%
Biodiesel	Canola Oil	7%
Biodiesel	Corn Oil	6%
Renewable diesel	Corn Oil	6%
Renewable diesel	Canola Oil	2%
All Others	All Others	1%
Gasoline/naphtha	Separated Food Wastes	1%
Ethanol	Separated Food Wastes	1%
Gasoline/naphtha	All Others	0.4%

Table III.C-3: Fuel/Feedstock Combinations for Conventional Renewable Fuel That Were Produced in the U.S. From 2016–2024

Fuel Type	Feedstock	Average Contribution to Total
Ethanol	Corn starch	>99%
Ethanol	Grain Sorghum	<1%

Table III.C-4: Average Proportions From 2016–2024 for Domestically Produced Feedstocks Used to Produced Biofuel

	Cellulosic	Non-Cellulosic Advanced	Conventional
Crop-based	<1%	63%	>99%
Non-crop-based	>99%	37%	<1%

The historical proportions shown in the tables above do not necessarily represent what might be expected in the future. As discussed more fully in Section III, our projections of the possible mix of renewable fuel types that could be used in the near future are based on a combination of information about historical trends and a knowledge of feedstock availability, infrastructure, and various other opportunities and constraints for the future.

D. Factors Affecting Actual Production and Use of Renewable Fuel

Once the EPA determines and establishes the overall volume requirements and associated percentage standards that will apply to RFS obligated parties (e.g., refiners and importers) for a particular year, the market determines precisely what renewable fuels are used. While EPA's volume rules, like the Set 2 Rule, specify specific volume requirements, in reality the *actual* volumes consumed in the marketplace often differ from those specific requirements. There are a handful of reasons for this.

The first is that the percentage standards set by the EPA are based on *projected* volumes of gasoline and diesel consumption, which typically deviate to some degree from what actually occurs. In the event that the actual consumption of gasoline and diesel is lower than the projection that the EPA used to set the applicable percentage standard in a given year, the obligations applicable to individual obligated parties are likewise lower, and the actual volumes of renewable fuel used as transportation fuel will fall short of the volumes the EPA assumed in setting the percentage standards. Likewise, if the actual consumption of gasoline and diesel is higher than the projection that the EPA used to set the applicable percentage standards, the actual volumes of renewable fuel used as transportation fuel will be higher. While the discrepancy typically falls within the range of a few percentage points, it can be much higher, as occurred in 2020 due to the impacts of the COVID-19 pandemic on fuel markets.

Another reason that the actual renewable fuel volumes used in a given year vary from the volumes at which the EPA set the standards is related to the Renewable Identification Number (RIN) credit system that is used to demonstrate compliance with the RFS program. Obligated parties have the flexibility to over-comply in one year and bank RINs for future use. Parties can then use these "carryover RINs" to demonstrate compliance in the subsequent year rather than using RINs representing current year renewable fuel production. The nationwide total of carryover RINs grew dramatically in the early years of the RFS program, and obligated parties have at times drawn down this carryover RIN bank to help fulfill their obligations.

The third reason that the actual renewable fuel volumes in a given year may vary from the volumes at which the EPA set the standards is the regulatory flexibility that obligated parties are afforded through the statute to carry a deficit from one year to the next. This provision allows them to fall short of their obligation to blend renewable fuel into their gasoline and diesel in one year by as much as 20%, so long as they compensate for that shortfall in the following year.

Fourth, exemptions for small refineries due to disproportionate economic hardship have historically resulted in actual consumption of renewable fuels falling short of the intended volume requirements. These exemptions are permitted under CAA 211(*o*)(9)(B) and are evaluated on a refinery-by-refinery basis. Prior to 2020, in cases where a small refinery hardship exemption was granted after the applicable percentage standards were set, the percentage standards in years past remained unchanged but were then applicable to a smaller number of parties. The EPA now projects small refinery exemptions and accounts for the projected exemptions when setting the percentage standards each year. Thus, small refinery exemptions should not result in reduction in actual renewable fuel volume.

Finally, there are many market factors beyond the RFS program itself that affect the consumption of renewable fuel. These include crude oil prices, renewable fuel production costs (which are in turn a function of feedstock and process heat and power costs), tax subsidies, and the demand for renewable fuel created by other federal and state programs. The California Low-Carbon Fuel Standard (LCFS) program in particular has and will continue to drive various renewable fuel volumes, and several other states are now implementing their own LCFS programs.

Combined, all of these factors make it challenging for the EPA to predict with certainty exactly how many gallons of renewable fuel will be used for transportation in the United States in a given year, let alone what the relative mix of the renewable fuel types will be.

IV. Description of the Action and the Action Area

A. The RFS Set 2 Rule Action

This BE addresses the impacts of an EPA action that will establish volume requirements for the use of renewable fuel in the transportation sector for years 2026–2027 under the RFS program. We refer to this action as the "Set 2 Rule."

As described in Section I.A, the Clean Air Act does not provide volume targets for years after 2022. Instead, CAA section 211(*o*)(2)(B)(ii) provides that the EPA shall, for years beyond those specified in the statute, determine the applicable volumes of each of the renewable fuel types. This is commonly referred to as the "set authority." In doing so, the EPA is to analyze a specified set of factors, but the CAA provides limited additional guidance to the EPA regarding how to determine appropriate RFS volumes. For most of the fuel types, the statute provides no specific numerical requirements. The EPA has used this authority to establish the biomass-based diesel volume beginning in 2013 and for each subsequent year. The EPA will also do so for all other fuel types in 2023 and later years.

The statute requires that the EPA establish these targets based on an analysis of the following criteria:

- The impact of the production and use of renewable fuels on the environment, including on air quality, climate change, conversion of wetlands, ecosystems, wildlife habitat, water quality, and water supply;
- The impact of renewable fuels on the energy security of the U.S.;
- The expected annual rate of future commercial production of renewable fuels, including advanced biofuels in each category (cellulosic biofuel and BBD);
- The impact of renewable fuels on the infrastructure of the U.S., including deliverability of materials, goods, and products other than renewable fuel, and the sufficiency of infrastructure to deliver and use renewable fuel;
- The impact of the use of renewable fuels on the cost to consumers of transportation fuel and on the cost to transport goods; and
- The impact of the use of renewable fuels on other factors, including job creation, the price and supply of agricultural commodities, rural economic development, and food prices.

1. Proposed Action

The EPA proposed applicable volume requirements for 2026–2027 on June 13, 2025 (*90 FR25784*) and has updated them for the final rule.

Table IV.A.1-1: Proposed Volume Targets (billion RINs)[a]

	2026	2027
Cellulosic biofuel	1.29	1.36
Biomass-based diesel[b]	8.69	9.19
Advanced biofuel	0.25	0.25
Renewable fuel	24.02	24.46

[a] One RIN is equivalent to one ethanol-equivalent gallon of renewable fuel.

Again, as noted above in Section II.B regarding the historical RFS volume requirements, these proposed volume requirements are not requirements for the use of specific types of renewable fuels, and thus regulated parties can and will use a variety of different renewable fuel types as long as they meet the qualifications (see Table III.A-1). With the Set 2 Rule, the EPA will only set the overall applicable volumes of renewable fuel that are required to be used in 2026 and 2027. Which types of fuels from which feedstocks and in what quantities ultimately are used is all left up to the market.

The EPA has nonetheless projected a plausible mix of renewable fuel types that might be used to meet the proposed standards and plausible estimates of the portion of those individual fuel types that could be attributable to the RFS program as discussed in the Set 2 Rule (as opposed to other economic, market, and regulatory factors). This potential mix is shown below.

Table IV.A.1-2: Projected Fuel Types Attributable to the RFS Set 2 Rule Proposed Volumes (million gallons)[a]

	2026	2027
CNG/LNG from biogas[a]	716	743
Diesel/jet fuel from wood waste/MSW	0	0
Biodiesel from soybean oil	1,139	1,161
Biodiesel from canola oil	295	292
Biodiesel from FOG[b]	-25	-28
Biodiesel from corn oil	118	141
Renewable diesel from soybean oil	1,294	1,544
Renewable diesel from FOG	901	879
Renewable diesel from corn oil	483	448
Ethanol from corn	212	228

[a] Provided in ethanol-equivalent gallons.
[b] FOG = Waste fats, oils, and greases.

The volumes in the table above represent those volumes that we believe might be attributable to the RFS program. They are less than the total volumes of these fuels that we project will actually be used for transportation in the U.S.

2. Final Action

The analyses in this BE were performed using our assessment of the volumes of renewable fuel that we projected would be supplied to meet the proposed volumes that are attributable to the RFS program. The RFS volumes targets we are finalizing for 2026 and 2027 are slightly different than the proposed volumes, as are the volumes of renewable fuel we project will be used to meet these volume targets that are attributable to the RFS program. To assess the impacts of the changing volumes from the proposed rule to the final rule we compared the volumes of biodiesel form soybean oil and canola oil and ethanol from corn we projected would be attributable to the Set 2 proposed rule to the volumes we projected would be attributable to the final rule. The differences in these volumes are summarized in Table IV.A.2-1.

Table IV.A.2-1: Biofuel Volumes Attributable the RFS Program in the Proposed and Final RFS Set 2 Rules (million gallons)

	2026			2027		
	Proposal	**Final**	**Difference**	**Proposal**	**Final**	**Difference**
Ethanol from Corn	212	231	+19	228	245	+17
Biodiesel from Soybean Oil	2,433	1,864	-569	2,705	2,267	-438
Biodiesel from Canola Oil	911	1,224	+313	908	1,380	+472
Total	3,556	3,319	-237	3,841	3,892	+51

As seen above the volumes attributable to the RFS program are varied for each biofuel in how they changed from the proposal. In general, the attributable volumes of biodiesel from canola increased in the final rule while the attributable volumes of biodiesel form soybean oil decreased. The attributable volumes of ethanol from corn did not change significantly. More information on these volume changes can be found in the RIA for the Set 2 rule.

After estimating the changes in the attributable volumes of each of the three major biofuels assessed in this BE from the proposed rule to the final rule we next assessed what effect, if any, these changes are expected to have on the estimates of land use change attributable to the Set 2 final rule. Table V.A.2-2 demonstrates the new acreage estimates based on the Set 2 final volumes attributable to the RFS program. More detail on the methodology used to project the land use change impacts associated with these biofuel volumes can be found in Section VI. The estimates of the increase in total land use change attributable to the final rule are lower than those estimated for the proposed rule. Using the higher acreage numbers from the proposed rule as the basis for our estimates of the impacts on listed species is therefore a conservative approach that overestimates the likely impact on these species.

Table IV.A.2-2: Estimated Land Use Change Associated Attributable to the Set 2 Proposed and Final Rule

Million Acres	**2026**		**2027**	
	Proposal	**Final**	**Proposal**	**Final**
Corn - Direct	0.094	0.102	0.101	0.108
Soybean - Direct	2.335	1.789	2.596	2.176
Canola - Direct	0.278	0.373	0.276	0.421
Total Cropland – Indirect[a]	0.725	0.725	0.725	0.725

Total	3.432	2.990	3.698	3.431

[a]For this comparison we have projected the same indirect effect for both the NPRM an FRM. Our estimate of the indirect effect is primarily a function of the increase in the volume of fuel attributable to each rule. The indirect effect of the FRM in 2026 is therefore likely an overestimate (because the 2026 FRM attributable volumes are lower than the NPRM attributable volumes), while the indirect effect or the FRM in 2027 is likely a very slight underestimate (because the 2027 FRM attributable volumes are about 1% higher than the NPRM attributable volumes).

The final rule also includes several other actions related to the RFS program, including a waiver of the 2025 cellulosic biofuel volume requirement, and a number of technical amendments intended to improve the operation of the RFS program. EPA's waiver of the 2025 cellulosic biofuel requirement results in a reduction in the required amount of cellulosic biofuel in 2025. Given the reduction in the cellulosic biofuel requirement, and the nature of the feedstocks used to make cellulosic biofuel as described in Section IV.B.5, we do not anticipate the waiver of the 2025 cellulosic biofuel requirement to have an effect on listed species or critical habitat. The regulatory changes relate to recordkeeping, reporting, and credit generation, and are therefore not expected to have any impact on volumes and therefore not on listed species or their habitats. These changes are:

B. The Action Area

1. Potential Locations That Comprise the Action Area

In Section IV.B, we describe how we define the action area for the Set 2 Rule. The EPA used the same action area that was delineated for the Set 1 Rule BE, and we explain later in this section why we think that was appropriate.

The action area for a BE is the area within the U.S. where potential effects are reasonably certain to occur. In the case of the RFS Set 2 Rule covered by this BE, the action area may encompass all locations in the United States where feedstocks used for renewable fuel are produced, transported, and used to produce biofuel that is consumed domestically. This potentially includes agricultural lands used for crop-based feedstocks as well as agricultural lands where crops used for non-biofuel purposes might be grown after being displaced from their current uses by the demand for biofuel production. It could further include lands used for non-crop-based feedstocks such as landfills, agricultural digesters, waste treatment plants, restaurants, and other facilities where biogas and waste oils, fats, and greases are collected and processed. We describe our close examination of these potential components of the action area in the subsections below.

While biofuels are also made from imported feedstocks, and biofuels from domestic feedstocks may lead to indirect effects overseas, for the purposes of this BE and consistent with Section 7 of the Endangered Species Act (ESA), we focus on the potential effects to species and habitat caused by land use change impacts within, and not outside of, the United States.

2. Crop-Based Feedstocks

Biofuels created from crop-based feedstocks may affect listed species and designated critical habitat by contributing to habitat loss via land use change as well as water quality impairments via runoff from agricultural lands.

The majority of biofuels produced and consumed in the United States are from crop-based feedstocks. As shown in Figure III.C-1, 75% of renewable fuel produced in the U.S. from 2016–2024 was made from conventional biofuel, of which nearly 100% constituted ethanol from crop-based corn starch (Table III.C-3). Another 23% of renewable fuel was made from non-cellulosic advanced biofuel (Figure III.C-1). Soybean, corn, and canola oils from crop-based feedstocks made up the majority (~63%) of the feedstocks used to produce non-cellulosic advanced biofuel (Table III.C-2). These data are from the years 2016–2024. In the proposed and final Set 2 rule we projected the volumes of different renewable fuel attributable to the RFS Set 2 rule (see Tables IV.A.1-2 and IV.A.2-2). The majority of the renewable fuel volumes attributable to the RFS program are projected to be produced from corn, soybeans, and canola, with smaller volumes of fuel produced from feedstocks not expected to impact listed species (biogas, MSW, and FOG).

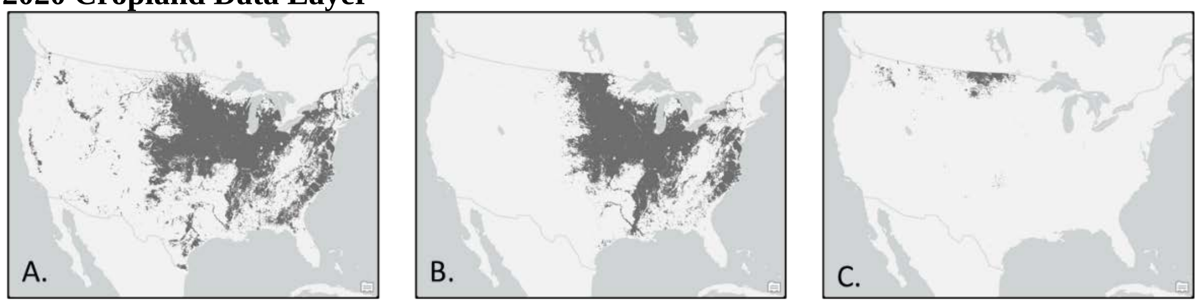
To examine where effects on listed species or critical habitat might be reasonably expected to occur, we focused the action area on the footprint of the U.S. where crop-based feedstocks are currently grown and could be grown in response to the RFS Set 2 Rule. In 2007, EISA included the following in the definition of renewable biomass: "planted crops and crop residue from agricultural land cleared or cultivated at any time prior to the enactment of this sentence that is either actively managed or fallow, and non-forested." (EISA, 2007) In doing so, Congress set limits on where crops for biofuel could be grown to prevent the conversion of other lands for the sole purpose of producing crop-based feedstocks to meet the standards in the statute. Therefore, one approach for this BE might be to assume that the action area footprint includes all lands cleared or cultivated on or before 2007.

However, using the lands cultivated or cleared in 2007 would not account for potential indirect land use impacts that may occur when non-biofuel crops on 2007 lands are displaced by the demand for renewable fuel. Hypothetically, if such displacement were to occur, the demand for crops for non-biofuel purposes could be met by increasing yields on existing cultivated lands outside of the 2007 lands, or in yet-to-be cultivated lands. As required under the Endangered Species Act, our assessment of potential impacts on species and habitat is made in the context of a specific EPA action. This BE is designed to address the Set 2 Rule which will establish standards for 2026–2027. As mentioned previously, we expect that corn, soybean, and canola will continue to be the predominant crop-based feedstocks produced domestically to meet the 2026–2027 volumes. To capture the broader action area that includes potential indirect land use impacts from displacement for biofuel demand, we believe that focusing on areas near where corn, soybean and canola are currently grown or could be grown provides a more accurate depiction of the action area rather than using the 2007 lands alone, an approach that would not account for potential indirect land use impacts.

3. Identifying the Area of Potential Land Use Change

To better understand which species may be affected by crop-based feedstocks and land use impacts driven by the RFS program, we used ArcGIS Pro to delineate the area of potential land use change. We used the Cropland Data Layer (CDL) from the United States Department of Agriculture (USDA)'s National Agricultural Statistics Service and Agricultural Research Service (NASS) to identify areas used to grow the predominant crop-based feedstocks used domestically for biofuel production (corn, soybean, and canola) in 2020. The CDL is a 30-meter raster, crop-specific data layer produced annually based on satellite imagery and extensive agricultural ground truthing. The year 2020 was chosen as it was the most recent year available at the start of our analysis. After downloading the 2020 CDL data layer, the corn, soy, and canola croplands were extracted (Figure IV.B.3-1) and converted to vector (polygon) data.

Figure IV.B.3-1: Corn (A), Soybean (B), and Canola (C) Croplands Extracted From the 2020 Cropland Data Layer



We then applied a 15-acre minimum mapping unit (MMU) filter. Applying a MMU (also known as minimum unit of change) filter is considered a best practice when using the USDA's CDL for land use and land cover change analyses (Lark et al., 2017) and is an approach that has been used widely by other researchers (Mueller & Saffrin, 2006) (Peterson et al., 2010) (Copenhaver et al., 2021). The filter we used was applied to corn, soybean, and canola lands to capture plots that are at least 15 acres in size. Using an MMU helps avoid random errors in the CDL where 30-m pixels may be misclassified. In addition, it removes small farm plot sizes that are unlikely to be used for commercial scale farming operations needed to support biofuel production and instead would likely be planted for other reasons (e.g., hobby farms, deer feeding, etc.).

Applying a 15-acre MMU was also important to avoid compounding errors that would result from applying a 5-mile buffer (described below) to the area where all corn, soy, and canola are grown as captured by the CDL. For example, we noticed the CDL sometimes properly characterizes small hobby farms and deer feeding plots in the Upper Peninsula of Michigan, where we know that large-scale farming and biofuel production do not occur within those smaller plots of land in that region. We wanted to apply a five-mile buffer as the next step in identifying the area of potential land use change and doing so without a 15-acre MMU filter would lead to capturing large 5-mile buffer areas surrounding those smaller plots of land for further analyses. However, including such areas would not be accurate as we are confident the

RFS program does not play a role and therefore does not affect threatened and endangered species in those areas.

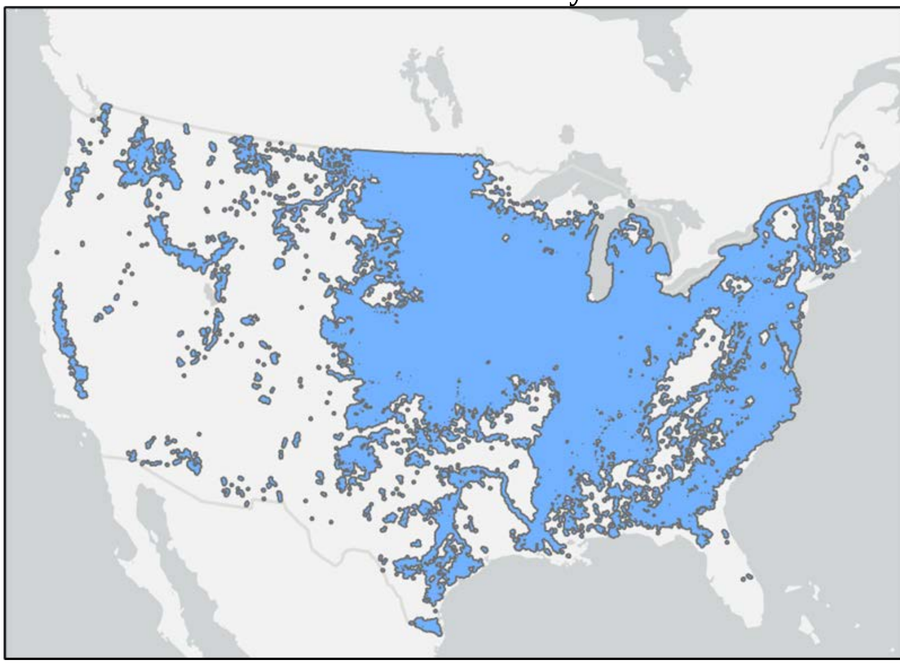
After applying a 15-acre MMU, we used the ArcGIS buffer tool which creates areas around features to a specified distance. Buffers are used widely in a variety of environmental assessments, including endangered species analyses. For example, the Office of Chemical Safety and Pollution Prevention in the EPA wrote a Revised Method (US EPA, 2020) which describes applying a buffer of 2,600 feet to capture the off-site transport of pesticides.

For our analyses, we chose to apply a five-mile buffer as a way to capture potential indirect land use change effects that occur when lands that are not used to grow biofuel feedstocks are displaced by the demand for biofuel production. The resulting area is shown in Figure IV.B.3-2. In this BE, we refer to this area as the "area of potential land use change." In defining this area, we also considered which crops are most likely to be displaced by the demand for biofuel production by considering which crops are predominantly grown on new croplands. Lark et al. (2020) found that corn was the predominant crop planted on newly cultivated land from 2008–2016. Corn was most common in all years except 2014–2015, when soybeans were more prevalent. Together with wheat, these three crops were the first plantings on over 78% of all new croplands nationwide (Figure IV.B.3-3). Assuming the same trends continue beyond 2016, the area we defined and depicted in Figure IV.B.3-2 includes all corn and soy. Wheat is one of the most common crops to be replaced by corn or soybean, and we calculated that the area of potential land use change also contains over 80% of the wheat land cover from the 2020 CDL. Thus, this area of potential land use change with the five-mile buffer likely covers the majority of wheat and other crops that may be displaced through indirect land use change effects.

To the extent that RFS volumes might have or will impact corn, soy, or canola plantings in the future, the commercial viability of increasing such plantings is almost certainly highest in and around the areas already being commercially harvested for these crops. Not only are the soil, water, and other climate conditions likely to be suitable for crop production, but the available infrastructure for planting, fertilizing, harvesting, storing, and transporting the crops is likely to be available in such areas.

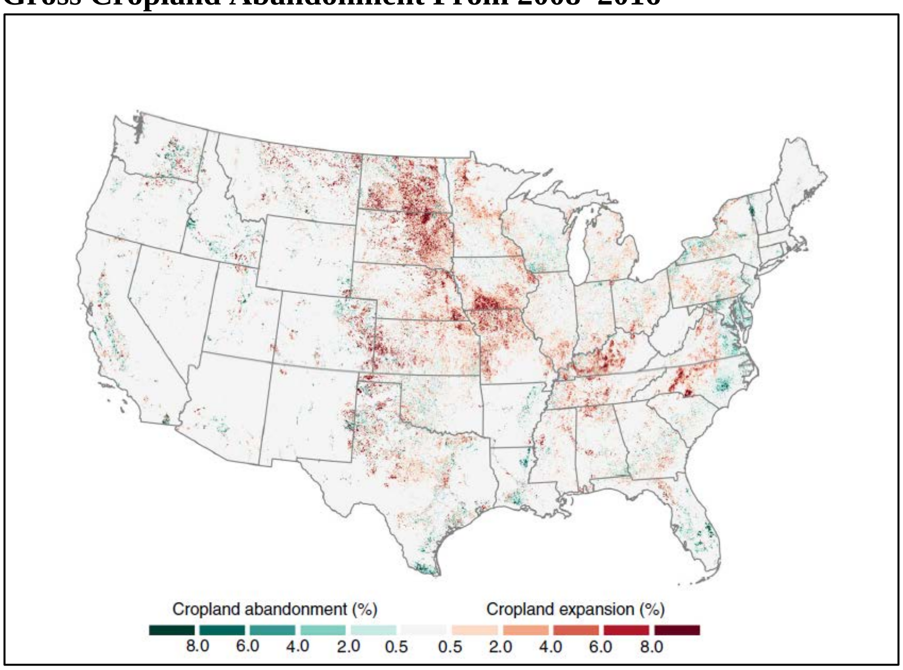
Further, it is important to note that within this area of potential land use change, it is possible that agricultural conversion would occur on lands that were once in cultivation, managed under the Conservation Reserve Program (CRP), or used for other uses such as pastureland. These lands already may not be suitable habitat with PBFs for species and therefore their conversion may not affect species at all. Based on a study from the Economic Research Service, 81% of former CRP land was put to some type of crop production, of which 57% transitioned to annual crop production, from 2013–2016. This conversion mainly occurred in the Corn Belt and the most common annual crops grown on expired CRP were soybeans, corn, and wheat. (Peoples Company, 2020).

Figure IV.B.3-2: Geographical Region Where Corn, Soybean, and Canola May Be Grown to Meet Biofuel Volumes as Established by the Set 2 Rule Covering the Years 2026–2027



Note: This region was identified by extracting corn, soybean, and canola croplands from the 2020 USDA Cropland Data Layer, applying a 15-acre minimum mapping unit filter, and applying a five-mile buffer.

Figure IV.B.3-3: Rates of Net Conversion Calculated as Gross Cropland Expansion Minus Gross Cropland Abandonment From 2008–2016



Source: Lark et al. (2020).

Because the 2020 CDL was used as the basis for identifying the Figure IV.B.3-2 area of potential land use change, we checked to see if it would still be appropriate to use for this BE on the Set 2 Rule, which focuses on potential land use and species effects in the years 2026 and 2027. To do so, in May 2024 we downloaded what was at the time the most up-to-date data (2023 CDL) for corn, soy, and canola. Using ArcGIS tools, we calculated that 99.8% of the 2023 data layer for the three crops falls within the existing action area. We did not apply a minimum mapping unit filter to the 2023 data, so it's possible that some or all of the 0.2% remaining data are representative of small hobby farms or small pixel errors/misclassifications by the CDL. With this analysis and result, we determined that the same area of potential land use change is appropriate to use for this BE. As such, the action area delineated based on this area of potential land use change, as described in subsequent steps below, is also appropriate to use for this BE.

4. Identifying Downstream Areas

If increased through land use changes caused by the Set 2 Rule, the production of crop-based feedstocks could potentially affect threatened and endangered species and critical habitat through agricultural non-point source pollution and water quality impacts. Generally, runoff from agricultural lands can transport excess nutrients (nitrogen and phosphorus), sediment, and pesticides (herbicides, insecticides, fungicides) into surrounding water bodies, contributing to water quality impairments in streams, rivers, lakes, and groundwater (Bales et al., 2010) (Mbonimpa et al., 2012) (Ryberg & Gilliom, 2015). Species that rely on healthy watersheds and aquatic ecosystems may therefore be adversely impacted by such impairments.

To ensure that we properly considered the full potential effects from the RFS Set 2 Rule, we took the area of potential land use change (shown in Figure IV.B.3-2) and expanded it to capture downstream regions that could be affected by agricultural non-point source pollution. To do so, we used the National Hydrography Dataset (NHD) Version 2 Catchment Data, NHD Version 2 Plus Attribute Flowline Value-Added Attributes, and the trace downstream tool on ArcGIS Pro. Using ArcGIS tools, points were allocated throughout the area of potential land use change, and the following parameters and data were used to determine the downstream flow path from those points: slope and elevation, stream order, and velocity of flow.

The resulting action area for the RFS Set 2 Rule is shown in Figure IV.B.4-1. To find which listed species and designated critical habitats are present within this area, we overlayed the action area in ArcGIS with shapefiles of listed species' ranges and critical habitat that were provided to us by FWS and the National Oceanic and Atmospheric Administration's (NOAA) NMFS. The action area is already inclusive of existing land used for agricultural production and therefore captures the impacts of intensification. The listed species with critical habitat and/or ranges within the action area are provided in the next section.

Figure IV.B.4-1: The Action Area for the RFS Set 2 Rule

5. Non-Crop-Based Feedstocks

It is also important to consider the potential role that the Set 2 Rule may have in impacting listed species and critical habitat through increases in non-crop-based feedstocks. As described below, we have made the determination that the production of these feedstocks does not affect listed species or critical habitat. We therefore did not alter the action area further to include effects from these feedstocks.

Waste fats, oils, and greases (FOG)

A fairly large portion (~37%) of non-cellulosic advanced biofuel in the U.S. is made from non-crop-based feedstocks (Table III.C-4). Non-crop-based feedstocks used to produce non-cellulosic advanced biofuel from 2016–2024 came from food wastes, waste oils, fats, and greases (Table III.C-2). Fats, oils, and greases (FOG) are generally byproducts of other food preparation industries that properly manage to avoid these potentially troublesome materials from entering drainpipes in the home or commercial food service operations. They are instead collected and either disposed of in landfills, recycled to produce various commercial products such as oleochemicals, or processed in wastewater treatment plants to produce biogas. An increasing portion has been used to produce biodiesel due to its low cost in comparison to crop-based feedstocks such as soybean oil and canola oil. However, this increasing use to produce renewable fuel has not resulted in an increase in their production, but only a change in their collection, use, or disposition. This can be seen in Table IV.A.2-2, as the no-RFS baseline analysis shows that, absent the RFS, the only thing that would change about the use of FOG is the produced renewable fuel.[13] The production of FOG will therefore not affect listed species or their habitats

[13] Throughout this Biological Evaluation we use the phrase "No RFS Baseline" to refer to the volume of biofuels that would be consumed in the U.S. absent the biofuel volume requirements imposed through the RFS program. The

because no reasonably certain causal link can be established to the RFS Set 2 Rule, and thus no causal impact on land use change or other environmental impact that can be attributed to the RFS Set Rule. As a result of this determination, this feedstock was not analyzed further.

Biogas

Cellulosic biofuel has historically reflected a small portion (2%) of all renewable fuel produced in the U.S. (Figure III.C-1). Nearly all cellulosic biofuel produced from 2016–2024 was CNG or LNG for use in natural gas vehicles, which utilize non-crop based feedstocks. We anticipate that in the 2026–2027 Set 2 Rule timeframe additional quantities of cellulosic biofuel will continue to be produced from biogas sourced from landfills and digesters.

Biogas from landfills is the largest source of cellulosic biofuel (90%), followed by biogas from agricultural digester and waste treatment plant sources (four and three percent, respectively; Table III.C-1). Neither landfills nor wastewater treatment plants are built for the purpose of producing biogas. Instead, they are built for the purpose of disposing of wastes, and biogas is a byproduct of their operation. Therefore, it is likely that no landfills or wastewater treatment plants will be built for the purpose of producing the biogas that would qualify as renewable fuel under the RFS program. However, some portion of the biogas that is already being produced or would be produced in the 2026–2027 timeframe is likely to be diverted from other uses such as electricity generation to use as a transportation fuel.

Agricultural digesters, in contrast, are typically built for the purpose of generating biogas. Such digesters typically process manure or crop residue such as corn stover. We acknowledge that new agricultural digesters may be built. If new agricultural digesters are built, they will most likely be located on the grounds of existing farms on land already cleared and used for farming activities.

Capturing biogas for the purposes of producing renewable fuel prevents methane from escaping into the atmosphere. This is important as, for instance, municipal solid waste landfills are the third-largest source of human-related methane emissions in the United States (US EPA, 2025a).

As a result of these considerations, the production of biogas will not affect listed species or their habitats because no reasonably certain causal link can be established to the RFS Set 2 Rule, and thus no causal impact on land use change or other environmental impact that can be attributed to the RFS Set Rule. As a result of this determination, this feedstock was not analyzed further.

No RFS baseline is a distinct concept from the term “environmental baseline” in the context of ESA Section 7 regulations We note as well that EPA’s use of the “No RFS Baseline” as a point of comparison is consistent with EPA’s approach in the Set 1 BE, and was upheld by the D.C. Circuit in *CBD v. EPA*, 141 4th 153 (2025).

Corn oil

Corn oil is a byproduct of ethanol production from corn. Ethanol production is based on fermentation of the starch found in corn, and the oil is not used in this process. Some oil is often left in the distiller's grains which are commonly sold as a high protein livestock feed. Oil that is extracted from the corn or distiller's grains has historically been used primarily for animal feed, with lesser amounts used in industrial products. Over the last 15+ years, a greater portion of corn oil has been diverted to use as a feedstock for the production of biodiesel due to its low cost. Similar to FOG, this increasing use to produce renewable fuel has not resulted in an increase in its production, but only a change in its use. Thus, there are no land use change impacts of this feedstock, and we do not anticipate that the processing of these feedstocks into renewable fuel will result in impacts to listed species or their habitats. As a result, the production of corn oil will not affect listed species or their habitats because no reasonably certain causal link can be established to the RFS Set 2 Rule, and thus no causal impact on land use change or other environmental impact that can be attributed to the RFS Set 2 Rule. As a result of this determination, this feedstock was not analyzed further.

V. Listed Species That Are Found Within the Action Area

Our analyses on ArcGIS found 731 unique species located within the action area shown in Figure IV.B.4-1. Out of the 731 unique species, 699 are FWS species; 40 are NMFS species (41 if the Atlantic Sturgeon Gulf subspecies are counted separately); and eight are both FWS and NMFS species. The eight species that are both FWS and NMFS species are the Gulf Sturgeon (Atlantic Sturgeon Gulf subspecies), Loggerhead Sea Turtle, Green Sea Turtle, Leatherback Sea Turtle, Hawksbill Sea Turtle, Kemp's Ridley Sea Turtle, Olive Ridley Sea Turtle, and Atlantic Salmon.

Though there are 731 unique species, some species have multiple Designated Population Segments (DPSs) or Evolutionary Significant Units (ESUs), culminating in a total of 821 unique populations found within the action area. It is important to assess populations separately, where applicable, as different species' populations may be found in different regions and could face different threats or rely on different PBFs or PCEs within their critical habitat. All 821 populations assessed in this BE have a listing status of endangered, threatened, proposed endangered, proposed threatened, or experimental population.[14] A listing status of "candidate" represents populations that are under review for qualification under the ESA; experimental populations are reintroduced populations that are geographically separated from nonexperimental populations. This BE only includes experimental populations representing FWS species. Per guidance from NMFS, the EPA does not consider NMFS candidate species or experimental populations in this BE.

"Attachment 1 – Table of All Listed Species from Set 2 BE" lists all populations and whether they have an associated designated critical habitat, range, or both critical habitat and range. Species populations are identified in this attachment in the "DPS or ESU (if applicable)" column and listing status is also provided.

In the analyses supporting this BE, we evaluated not only the range of potentially affected populations but also critical habitat. These two data types must be considered separately. A range for a species is the geographical area where a particular species may be found. In contrast, critical habitat includes geographic regions that contain PBFs or PCE that are considered essential for the conservation of a listed species.

As was done in the Set 1 BE, upon further discussion with NMFS during the consultation process, the EPA did not include many of the marine and coastal NMFS species in additional analyses or discussions in this BE due to discountable or insignificant effects potentially attributed to land use changes from the RFS Set 2 Rule. Potential consequences from the action pertaining to water quality (e.g., pesticide exposure, as discussed in more detail in later sections) and species' responses to such potential effects are discountable for populations that are found in offshore or circumpolar regions, far enough away from the pollution source where exposure would not likely occur due to dilution in marine waters.

[14] There were no FWS candidate species with habitat or range intersecting with action area.

This applies to the following cetaceans (and their associated critical habitats) which receive NLAA determinations because effects, if any, are discountable: Sei Whale, Rice's Whale, Blue Whale, Finback Whale, all listed Humpback Whale DPSs, and Sperm Whale.

Other marine NMFS species that fully or partially reside or have critical habitat in more shallow, coastal waters could be exposed to water quality effects caused by potential land use changes driven by the RFS Set 2 Rule. Although exposure is possible, we do not anticipate adverse effects to these species because their responses to that exposure would be undetectable and not measurable relative to current conditions and would not rise to the level of take. In the case of pesticide exposure attributed to the RFS Set 2 Rule, the risk of bioaccumulation and/or biomagnification in larger animals (e.g., North Atlantic Right Whale) would be very low. For species whose critical habitat PBFs include prey availability, potential impacts are insignificant for species whose prey are wholly marine. Additionally, we anticipate that any potential effects from the RFS Set 2 Rule would not meaningfully reduce the prey populations and food sources found in more freshwater or estuarine ecosystems, and thus not adversely affect the listed species who rely on those food sources. For other PBFs, such as nearshore reproductive habitat (e.g., for many sea turtles), potential effects would also be undetectable and not measurable.

Species that receive insignificant effects due to reasons as described above include: the North Atlantic Right Whale, Killer Whale (Southern Resident population), North Pacific Right Whale, False Killer Whale Main Hawaiian Islands Insular population), Olive Ridley Sea Turtle (Mexico's Pacific coast breeding colonies and all other areas populations), Leatherback Sea Turtle, Loggerhead Sea Turtle (Northwest Atlantic Ocean and North Pacific Ocean populations), Green Sea Turtle (North Atlantic and East Pacific populations), Hawksbill Sea Turtle, Kemp's Ridley Sea Turtle, Elkhorn Coral, Lobed Star Coral, Mountainous Star Coral, Boulder Star Coral, Steller Sea lion (Western population), Guadalupe Fur Seal, Oceanic Whitetip Shark, Scalloped Hammerhead Shark (Central & Southwest Atlantic population), and Giant Manta Ray. Though the Southern Resident Killer whale depends on salmon for food (e.g., the Chinook salmon), the potential effects of the RFS Set 2 Rule on these salmon populations are also considered to be discountable, as discussed in later sections. As such, this group of marine and coastal species is not further evaluated in the ensuing analyses for this BE.

VI. Changes in Land Use Attributable to the RFS Set 2 Rule

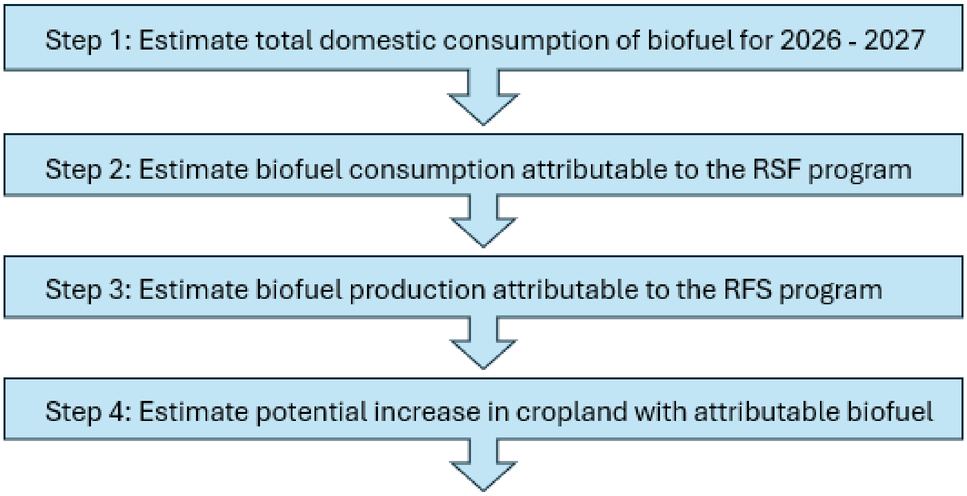
As discussed in the preceding sections, the RFS volume requirements for 2026–2027 may affect listed species primarily by increasing demand for corn, soybean, and canola feedstock crops used to produce biofuels. The increased demand for these crops could impact listed species in two different but inter-related ways. First, increased demand for these crops could result in an increase in the amount of land used to produce these crops. This increase in the amount of land used to produce corn, soybeans, and canola could come from cropland currently being used to produce other crops or from the conversion of non-cropland to cropland to produce corn, soybeans, canola, or other crops displaced by these crops. These land use changes could impact species with critical habitat or ranges on converted land. Further, increased production of these crops could result in an increase in the quantity of fertilizer, herbicides, pesticides, and sediment in waterways that are close to or downstream of land used to produce these crops. This could negatively affect species that live in or near the impacted waterways. Increased production of these crops could also result in direct and indirect impacts to terrestrial species that use crop lands or lands adjacent to them.

This section discusses a plausible projection of land use changes associated with the RFS volume requirements for 2026–2027. For this BE, we projected the land use changes associated with increased demand for corn, soybeans, and canola for biofuel production that is attributable to the Set 2 Rule. To project land use changes associated with increased demand for biofuels we used the best available data and analytical techniques from published literature. The methodologies used to project land use change attributable to increased demand for biofuels were designed to address the same issues and steps in connecting the Set 2 Rule with potential impacts on species and habitats, as shown in Figure ES-1. We provide an overview of the methodologies used to project land use change associated with increased demand for corn, soybeans, and canola, and the results of these analyses. In Sections VII and VIII, we discuss in more detail the potential impacts on listed species and critical habitat from the estimated land use changes (Section VII), and the potential impacts on listed species and critical habitat from changes in water quality (Section VIII).

A. Relationship between Biofuel and Crop Production

Our estimations of the impacts of future biofuel production attributable to the standards established through the Set 2 Rule on species and habitat is complicated by a multitude of factors as discussed in detail in Appendix A. (See Figure ES-1).

Figure VI.A-1: Process for Estimating Impacts of Biofuel on Cropland



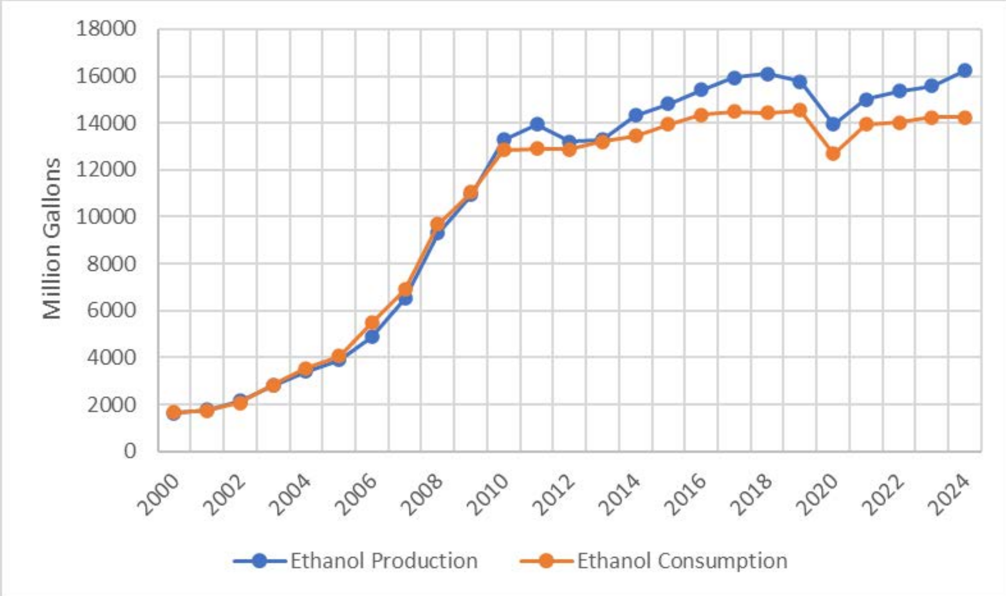
To assess the impact of potential increased biofuel production attributable to the Set 2 Rule begins with estimating the increase in cropland attributable to each biofuel. As we note in the figure above, the final result is to estimate the potential increase in cropland nationwide. Once this analysis of potential cropland increases attributable to the Set 2 Rule is complete, it allows the EPA to evaluate the potential impact on species and their critical habitats.

1. Corn and Ethanol Production

Before assessing the impacts of the Set 2 Rule on ethanol and corn production for the period 2026–2027, we first provide some context on the historic relationship between corn and ethanol production and factors that have contributed to the growth in domestic ethanol production since the RFS program began in 2006. This historical context helps to explain why only a small portion of ethanol production in the 2026–2027 timeframe is reasonably certain to occur as a direct result of the standards established through the Set 2 Rule.

Although ethanol use in transportation has existed since the late 1800s, its use as an oxygenate in gasoline emerged in the 1980's. Since then, use has been steadily climbing and reached a more drastic increase in 2002. It became a key replacement for the gasoline oxygenate methyl tertiary butyl ether (MTBE) which had been causing concerns of groundwater contamination. From 2000 through 2010 a number of factors, including state and federal renewable fuel mandates, state and federal tax incentives, and improved ethanol blending economics driven by relatively high oil prices and a shift to match blending to take advantage of ethanol's high octane rating, lead to a rapid increase in the domestic consumption of ethanol. This consumption increase can be seen in the graph below.

Figure VI.A.1-1: U.S. Fuel Ethanol Consumption and Production

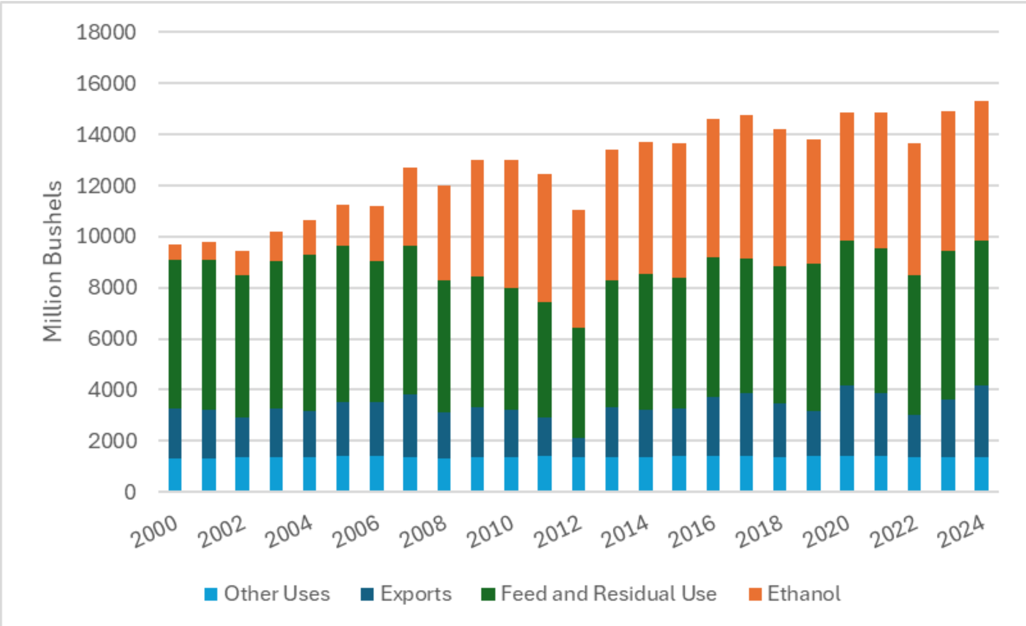


Source: U.S. Energy Information Administration (EIA)

After increasing rapidly from 2000–2010, domestic ethanol consumption increased at a more modest rate from 2010–2020. This plateauing of domestic ethanol consumption occurred as the national blend rate for ethanol in gasoline approached 10%. While retail sales of gasoline containing more than 10% are available in some locations, these blends are available at a relatively small number of retail stations, as most retail stations require infrastructure modifications to be able to sell gasoline blends containing greater than 10% ethanol. To address these infrastructure constraints, in 2016 the USDA initiated the Biofuels Infrastructure Partnership (BIP) which provided grants to aid in the increased use of higher biofuel blends. This was followed by the Higher Blends Infrastructure Incentive Program (HBIIP) which granted to same incentives for upgrading infrastructure to handle expanded biofuel use. These two programs helped lower the cost for business to install upgraded pumps, storage tanks, and dispensers for increased distribution of ethanol.

As the production of ethanol from corn increased over the last 20 years, production of corn also increased.

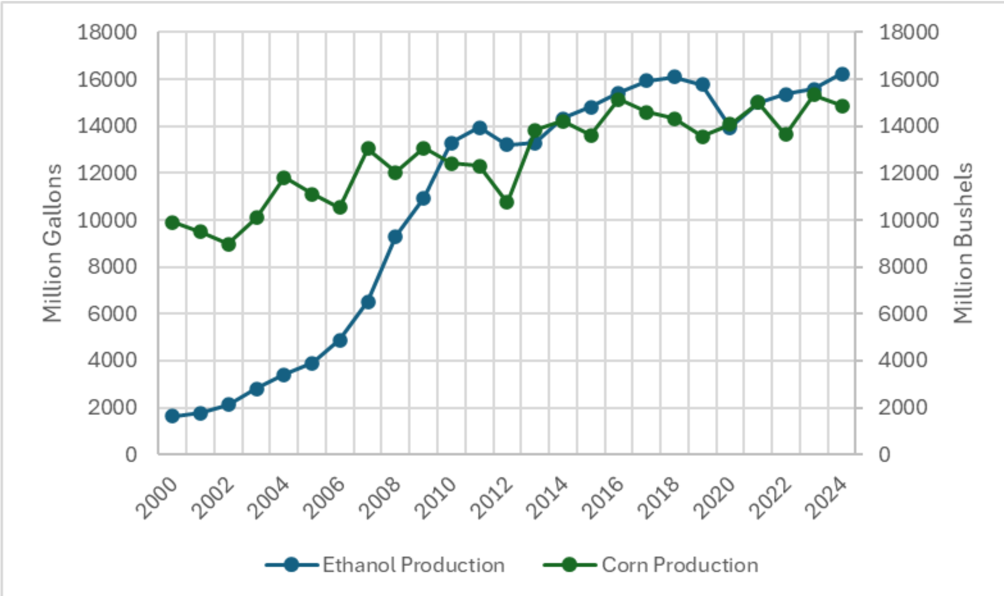
Figure VI.A.1-2: U.S. Corn Production and Portion Used for Fuel Ethanol, Feed, and Other Uses



Source: DOE's Alternative Fuels Data Center (https://afdc.energy.gov/data). Original data taken from United States Department of Agriculture, Economic Research Service, Feed Grains Yearbook (https://ers.usda.gov/data-products/feed-grains-database/feed-grains-yearbook-tables).

As shown in Figure VI.A.1-1, U.S. ethanol production increased dramatically in the 2007–2012 timeframe. In the past decade, however, ethanol production and corn used for ethanol production have been relatively stable. Total corn production and corn used for feed and other markets have continued to increase. This observation suggests complexity in the market response to increased demand for corn for ethanol production. Increasing the demand for corn by one bushel for ethanol production historically has not resulted in a one bushel increase in domestic corn production. At the same time, increasing consumption of corn in non-ethanol markets in the past decade has seen a continued increase in corn production during a time when ethanol production was relatively stable. Figure VI.A.1-3 illustrates this complexity and the lack of a correlation between domestic ethanol production and domestic corn production since 2011.

Figure VI.A.1-3: Ethanol and Corn Production in Recent Years



Source (corn production): USDA Economic Research Service
Source (ethanol production): U.S. Energy Information Administration (EIA)

If changes in ethanol production were perfectly correlated with corn production, we would expect to see them rise and fall in tandem. While there does appear to have been a stronger correlation between domestic ethanol production and domestic corn production from 2007 2012, it does not seem to correlate nearly as strongly in recent years between 2019–2023 (US EPA 2025b). These interactions are very likely the result of multiple factors affecting corn production and/or ethanol production and highlight the difficulty in determining whether and to what degree the ethanol volumes attributable to the Set 2 rule shown in Table IV.A.2-2 would lead to changes in corn production. Our assessment of the projected impact of increasing production of corn ethanol on corn acreage in the U.S. and total cropland in the U.S. is discussed in Section VI.C.

2. Soybean and Biodiesel Production

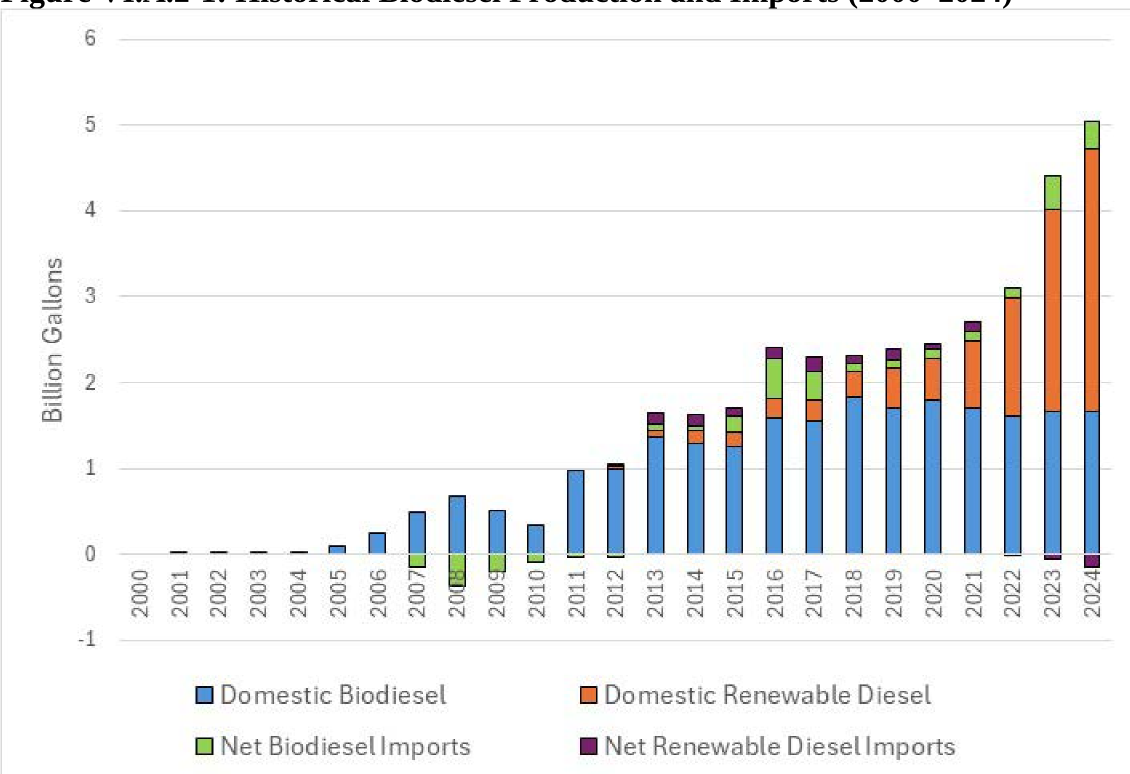
After ethanol, the fuel produced in the largest quantities to satisfy RFS obligations is biodiesel, which displaces petroleum-based diesel fuel. Biodiesel[15] is currently produced from a wide variety of feedstocks, including FOG, distillers corn oil, and virgin vegetable oils (see Table III.C-2). FOG are waste products collected primarily from restaurants, animal processing facilities, and wastewater treatment plants, while corn oil is a byproduct of corn ethanol production. In the U.S., soybean oil is the vegetable oil used in the largest quantities for biodiesel production, while smaller amounts of these fuels are produced from canola oil.

[15] Note that references to "soy biodiesel" and "canola biodiesel" will encompass both biodiesel and renewable diesel.

In the section below, the EPA provides an overview of historical biodiesel production, soybean markets, and soybean end uses.

As with ethanol, there are many different factors that influence the domestic production and use of biodiesel in any given year. These factors include, but are not limited to, the relative pricing of vegetable oils and other feedstocks used to produce biodiesel and crude oil, federal tax credits, state and local mandates and incentives, and the RFS volume requirements. Due in large part to federal and state incentives, including the RFS program, the production and use of biodiesel have increased significantly since 2010.

Figure VI.A.2-1: Historical Biodiesel Production and Imports (2000–2024)



A majority of all biodiesel produced since 2016 has been produced from crop-based feedstocks, the majority of which was soybean oil.

Table VI.A.2-1: Proportions of Feedstocks Used to Produce Domestic Biodiesel From 2016–2024

	2016	2017	2018	2019	2020	2021	2022	2023	2024	Average[a]
Soybean oil	45%	44%	48%	48%	53%	48%	44%	39%	35%	43%
FOG	30%	30%	28%	30%	28%	30%	37%	43%	42%	35%
Corn oil	14%	15%	16%	15%	12%	15%	14%	10%	11%	13%
Canola oil	12%	11%	8%	7%	7%	7%	6%	9%	12%	9%

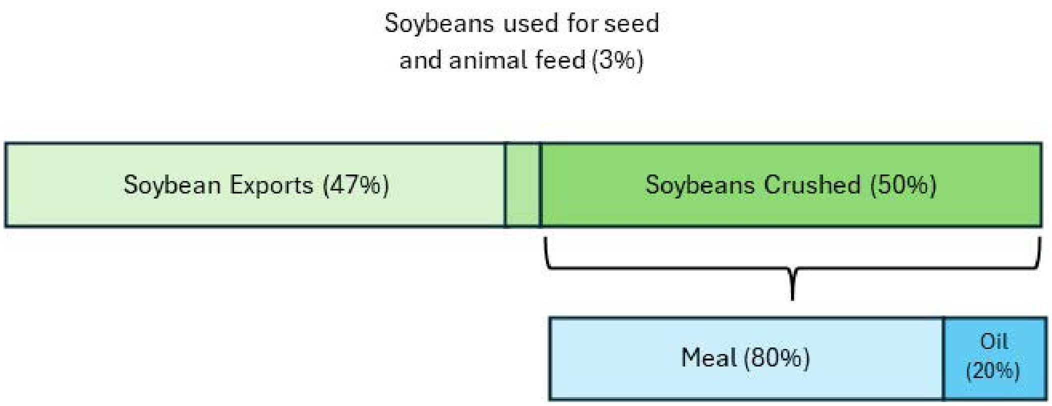
Source: EPA's Moderated Transaction System (EMTS).
[a] Volume weighted average

Since we do not anticipate any adverse impacts on species or their habitats for non-crop feedstocks such as FOG, and the production of those feedstocks is not attributable to the RFS program, we have focused on the production of soybeans and canola for the purposes of this BE. However, in order to project the volumes of soybean oil that might be used in the future to produce biodiesel, we have also projected potential volumes of FOG and corn oil.

Projecting the impact of the RFS program on soybean planting is complicated by the fact that there are multiple markets, and therefore multiple economic factors, that impact the demand for soybeans and soybean oil in the U.S. Therefore, before addressing our assessment of the impacts of the RFS program on soybean oil consumption and, ultimately, on soybean plantings, we provide here an overview of the soybean market to provide context for the later discussion.

In the U.S., soybeans are grown for two primary purposes: export and crush, in roughly equal proportions (See Figure VI.A.2-3). Soybeans that are crushed yield meal and oil, with the oil comprising about 19% of the total mass crushed. Parties that use soybean oil and meal produced by soybean crushers generally purchase these products from crushing facilities, rather than purchasing whole soybeans directly from soybean farmers.

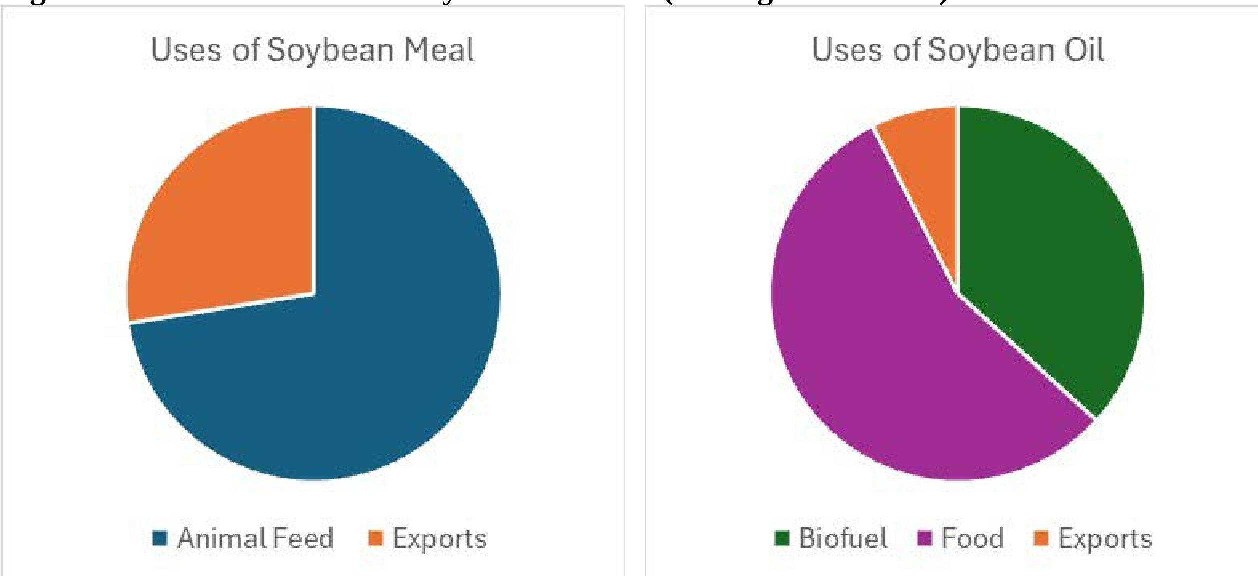
Figure VI.A.2-2: Typical Uses of Soybeans (Average 2016–2024)



Source: USDA’s Economic Research Service.

Like whole soybeans, some portion of both the meal and the oil are exported to meet foreign demand. In terms of domestic use, the remaining meal is used primarily for animal feed while the remaining oil is used for food, industrial purposes, and biofuel. A small share of soybean oil is also imported, generally around 1-2% of domestic consumption. Figure VI.A.2-3 shows the proportional uses of meal and oil on average for the years 2016–2024.

Figure VI.A.2-3: Markets for Soybean Products (Average 2016–2024)



Source: USDA's Foreign Agricultural Service.

The use of soybean oil to produce biodiesel has accounted for an average of about 36% of all soybean oil produced in the 2016–2024 timeframe. Since soybean oil was produced from 50% of soybeans over the same timeframe, we could conclude that about 19% (37% × 50%) of total domestic soybean production was used for biofuel production. However, this calculation ignores the impact that demand for soybean meal and soybean exports have on domestic soybean production. To appropriately project the impact of biofuel production generally and the RFS program specifically on domestic soybean production in future years we must also consider trends in demand for soybeans and soybean products in non-biofuel markets.

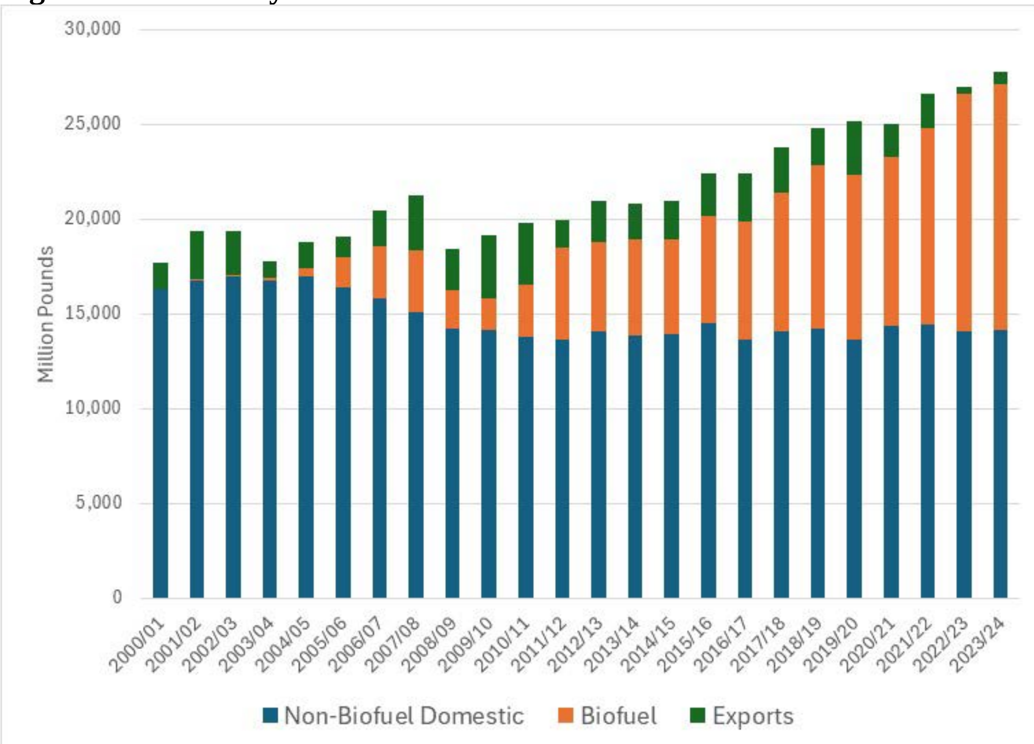
Estimating the impact of the RFS program on domestic soybean production is complicated by several factors. First, both soybeans and soybean oil have a number of different markets, each of which could potentially impact soybean production in the U.S. The primary uses for soybeans in the U.S. are crushing to produce soybean oil (used in a wide variety of domestic markets, including fuel, food, and industrial) and soybean meal (for domestic use as animal feed) and exports (for similar uses abroad), with a very small quantity of soybeans used for seed, feed, and other uses (See Figure VI.A.2-4). From the 2000/2001 crop year to the 2023/2024 crop year, domestic soybean crush has increased by approximately 650 million bushels, or approximately 40%. Soybean exports increased by nearly 700 million bushels during this period, an increase of over 70%. Soybeans used for seed, feed, and other uses have remained fairly consistent, decreasing slightly from 2000/2001 to 2023/2024 (see Figure VI.A.2-4). Because there are multiple demand drivers for increased soybean production, we cannot simply assume that the RFS program is responsible for the increase in soybean production since the inception of the RFS program. In fact, these data indicate that much of the increase in soybean production over the past 20 years has been driven by increased exports to meet demand in foreign markets, while a relatively small portion (approximately 30%) of the increase in soybean production has been due to increases in demand for soybean crushing to produce soybean meal and soybean oil.

Figure VI.A.2-4: U.S. Soybean End Uses

Source: USDA Oil Crops Yearbook (March 2025); Data for 2023/24 is an estimate.

Similarly, soybean oil is used extensively as an input for many products beyond biofuels, for example in food, cleaning products, bioplastics, and cosmetics. Soybean oil is also exported for use in other countries. USDA reports total consumption of soybean oil, including the quantity of soybean oil used for biofuel production, as well as soybean oil exports. These data are summarized in Figure VI.A.2-5.

Figure VI.A.2-5: Soybean Oil End Uses



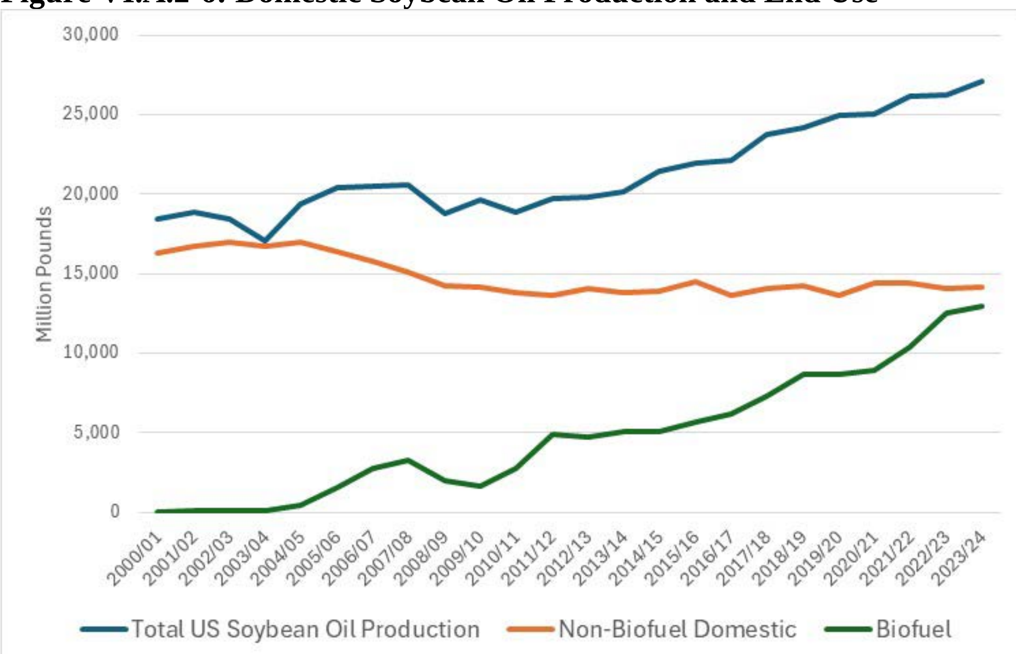
Source: USDA Oil Crops Yearbook (March 2025); Data for 2023/24 is an estimate.

Historically, the majority of the value of soybeans (approximately 60-70% on average in recent decades) has come from the meal. Soybean oil has historically accounted for a little less than half of the total value of crushed soybeans, with soybean meal for livestock feed accounting for more than half of the total value. In the early years of the biodiesel industry one of the perceived benefits of biodiesel production was to provide another market for excess soybean oil resulting from meal production. It provided a higher value market for soybean oil than the existing markets for food, cosmetics, and industrial applications, which in turn could reduce the prices for soybean-based animal feed and/or increase the price farmers received for soybeans (Schmidt, 2007).

While some biodiesel is produced at large integrated soybean processing facilities that also crush soybeans and produce a variety of end products, most biodiesel and renewable diesel producers purchase soybean oil from soybean crushing facilities. Soybean crushing facility capacity is a crucial potential limitation on the ability to produce and obtain domestic soybean oil for biofuels and other uses. Currently, existing domestic soybean crushing facilities are operating at or near that total capacity. Even in a scenario where demand for biodiesel and renewable diesel was to increase significantly, the capacity of existing domestic soybean crushing facilities could limit the quantity of soybean oil that can be produced domestically and used to produce biofuel. In such circumstances, increasing biodiesel and renewable diesel production would require sourcing feedstock from non-crop sources (FOG, distillers corn oil, etc.) or diverting soybean oil from other markets. In either case, because soybean crushing facilities are already operating at or near capacity there would be little or no near-term increase in soybean demand from crushing facilities in such a scenario and thus little to no market signal for U.S. farmers to increase soybean production. Increasing soybean crushing capacity is therefore necessary for any increase in demand for soybean oil or meal to result in an increase in soybean planting. As discussed further in the following section, we have used USDA projections to estimate increases in soybean crushing capacity, and the resulting increase in soybean planting through 2025.

Notably, while the quantity of soybean oil produced in the U.S. has steadily increased since 2000/2001, these increases have been more modest than the increase in soybean oil that has been used for biofuel production during this same time period (see Figure VI.A.2-6). Since 2000/2001 approximately two-thirds of the soybean oil used to produce biofuels have come from increased soybean oil production, while approximately one third has come from diverting soybean oil from other markets to biofuel production. While some of the decrease in the use of soybean oil for non-biofuel uses may have been due to increased demand for biofuel production, other factors, such as the Food and Drug Administration's prohibition on the use of partially hydrogenated oils in food products, also impacted demand for soybean oil in non-biofuel markets (Human Foods Program, 2024).[16]

Figure VI.A.2-6: Domestic Soybean Oil Production and End Use



Source: USDA Oil Crops Yearbook (March 2025); Data for 2023/24 is an estimate.

In summary, it is difficult to project with precision the likely impact of the RFS program on soybean planting in 2026–2027. This task is complicated by a variety of factors, including a wide variety of feedstocks that can be used to produce biodiesel and renewable diesel under the RFS program, the different markets for soybeans and soybean oil, and potential limitations in soybean crush capacity. These confounding factors make it difficult to project the degree to which any increase in demand for soybean oil attributable to the RFS program would induce farmers to increase soybean production in 2026–2027. This inherent uncertainty means that we

[16] In 2013 FDA made a preliminary determination that partially hydrogenated oils are not generally recognized as safe for use in food. This determination was finalized in 2015.

cannot say, with certainty whether or where changes in soybean planting will occur in response to changes to the RFS program. In light of these uncertainties, we believe that methodologies that forecast future land use change based on observed historical responses to increasing biofuel production are most appropriate for projecting the potential impact of future biofuel production attributable to the RFS program.

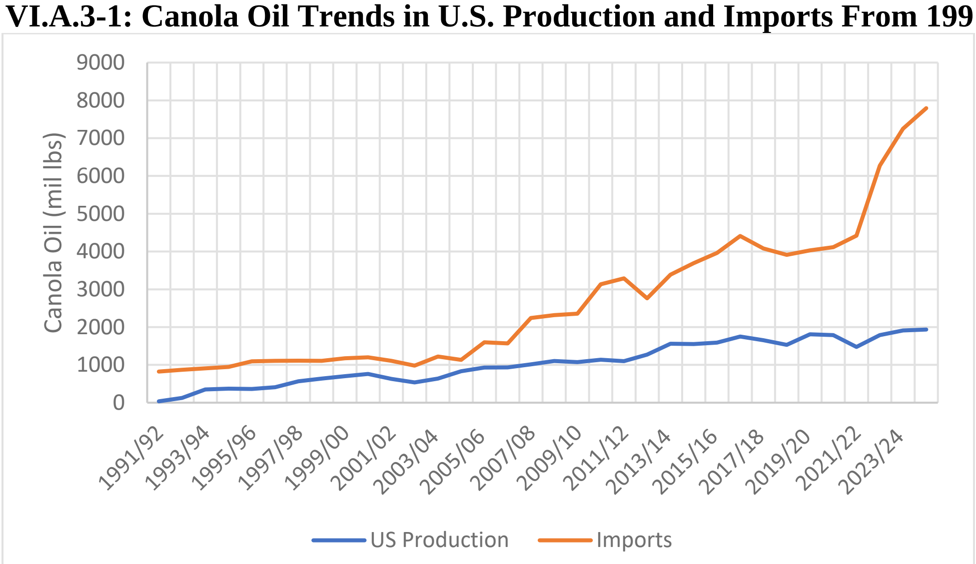
3. Canola and Biodiesel Production

The final oilseed in our evaluation is canola, which in comparison to corn and soybean use in biofuel production is small. However, it is the largest of the remaining group of crops used in biofuel use and thus important the EPA's BE for the Set 2 Rule.

Canola is a significant oil crop in Canada but has established a small yet prominent growing area in the northern-midwest of the U.S. as well. Similar to soybeans, canola seed is processed through a crushing facility to produce both oil and meal. The meal is used primarily for animal feed. The oil produced is used for food markets and in the production of biofuel. The U.S. and Canada have both approved the use of canola oil in their clean and renewable fuels programs, which have gradually increased its use in recent years. The EPA approved a general canola oil pathway for the RFS program in 2022 allowing for the use of canola-based biodiesel to accrue RINs.

Domestic biofuel producers source canola oil from both domestic and foreign canola crushing facilities (see Figure VI.A.3-1). Since 2000, domestic production of canola oil has increased by approximately 300%, from approximately 750 million pounds in 2000/2001 to nearly 2 billion pounds in 2023/2024. During this same period, imports of canola oil have increased much more substantially. Imported canola oil currently represents about 80% of the total supply of canola oil to the U.S.

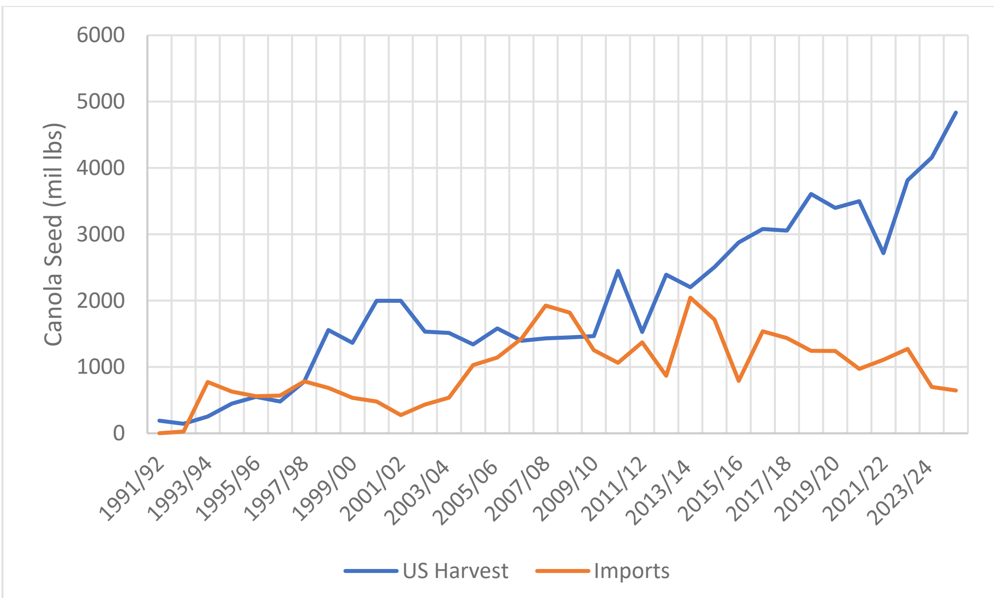
Figure VI.A.3-1: Canola Oil Trends in U.S. Production and Imports From 1991 to 2024



Source: USDA National Agricultural Statistical Services

In addition to imported canola oil, the U.S. is also an importer of canola seed. Figure VI.A.3-2 shows trends in domestic canola seed production and imports of canola seed. From 2005 through 2010 approximately half of the total supply of canola in the U.S. was domestically produced, while the other half was imported. Since 2010 domestic canola production has increased significantly, while imports of canola have decreased. As of 2023/2024 domestic production represents approximately 85% of the total supply of canola in the U.S., while imports represent only 15% of the total U.S. supply. Despite this significant increase in the U.S. production of canola, canola remains a relatively minor oilseed crop in the U.S., total domestic canola production (approximately 3.8 billion pounds in 2023/2024) about 1.5% of total soybean production in the same year (approximately 250 billion pounds).

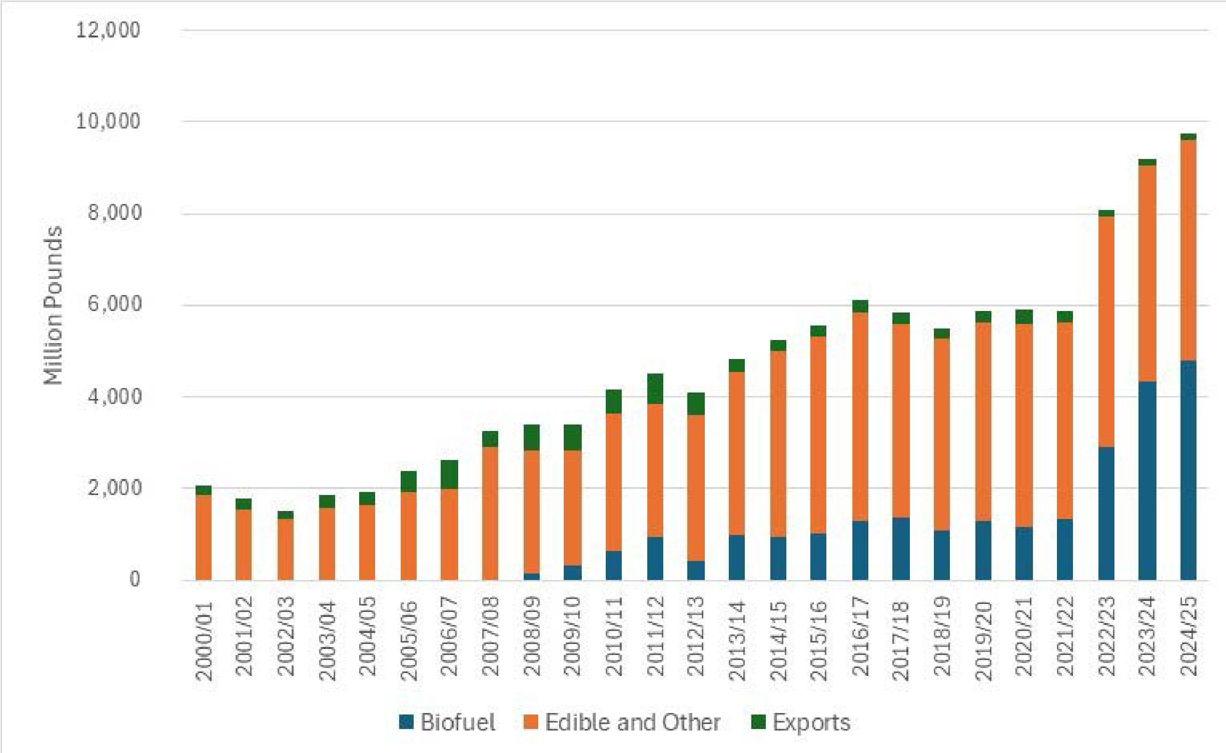
Figure VI.A.3-2: Canola Seed U.S. Harvest and Import Trends from 1991 to 2024



Source: USDA National Agricultural Statistical Services

As with soybean oil, canola oil has many different end uses. Canola oil is not only used for biofuels but also in the food market and can be utilized as a petroleum alternative in plastics production. Historically most canola oil in the U.S. has been used as edible oil in food markets. However, after EPA approved a pathway for renewable diesel produced from canola oil to generated biomass-based diesel RINs in December 2022 use of canola oil for biofuel production has increased significantly. The end uses for canola oil in the U.S. are shown in Figure VI.A.3-3.

Figure VI.A.3-3: Canola Oil End Use



The significant increase in the use of canola oil as a feedstock for biofuel production following the approval of the canola oil renewable diesel pathway in late 2022 suggests that biofuel production may be a primary driver of demand for canola oil in the U.S. Much of this increase, however, appears to have been met with increased imports of canola oil rather than increased domestic production (see Figure VI.A.3-1). From 2021/22 to 2023/24 domestic production of canola oil increased by approximately 450 million pounds, while imports of canola oil increased by nearly 3 billion pounds. We do not have precise data on biofuels produced from domestic canola oil vs. imported canola oil. Despite this, the relative dominance of imported canola oil over domestic canola, both with respect to the total supply and the increase from 2022, strongly suggests that the primary impact of increased production biofuels from canola oil since 2022 has increased imports of canola oil rather than increased domestic production. We therefore project that most of the land use change associated with increased demand for canola oil for biofuel production in the U.S. would occur in foreign countries, with smaller impacts on canola and canola oil production in the U.S.

B. Biofuel Production Attributable to the Set 2 Rule

For the purposes of a BE, the impact of a federal action is determined in part by assessing what would occur in the absence of that action as a means to identify the consequences that would not occur but for the proposed federal action. Or, as expressed by 50 C.F.R. § 402.02, a particular consequence must be “reasonably certain to occur” for it to be caused by the agency action under review. In addition to the RFS program, a number of other factors contribute to the production and use of biofuel in the U.S., including other federal, state, and local incentives, as well as the economic competitiveness of biofuels relative to petroleum-based fuels. Thus, the absence of the RFS program or the Set 2 Rule would not mean the absence of biofuel utilized nationwide. Absent the support for renewable fuel production and use we would still project, for example, that some volume of ethanol and biodiesel would be used as alternatives to gasoline and diesel. To project the impact of the Set 2 rule on listed species we must first project the quantity of renewable fuels that would be used in the absence of this rule. We refer to the volume of renewable fuel that we project would be produced in the absence of the Set 2 rule as the "No RFS baseline." We then project the volume of renewable fuel production and use attributable to the rule by calculating the difference between the volumes of renewable fuel we project would be produced and used with and without the Set 2 rule. Below we will discuss further the No RFS Baseline and how that reflects the volumes we believe are attributable to the Set 2 Rule. For further detail on our projection of the No RFS baseline, see Chapter 2 of the Regulatory Impact Analysis (RIA) for the Set 2 rule.

As discussed in Chapter 2 of the Set 2 DRIA, the No RFS Baseline represents our projection of biofuel consumption in the U.S. if EPA were to not finalize RFS volume requirements for 2026 and 2027. Conceptually, the No RFS Baseline allows EPA to directly project the impacts of the finalized and alternative volume scenarios for 2026 and 2027 relative to a scenario without volume requirements. When estimating the No RFS baseline, we assumed that non-RFS federal and state programs that support renewable fuel production and use (e.g., the federal renewable fuels production credits and state LCFS programs), would continue to exist in 2026 and 2027; in other words, the only current policy not in place in this baseline scenario is the RFS standards.

In determining the No RFS Baseline we assumed that all state mandates for renewable fuel use would continue, and that additional volumes of renewable fuel would be used if these fuels could be provided at a lower price than petroleum-based fuels, after taking into account available federal and state incentives. The differences between the Volume Scenarios and the No RFS Baseline represent the volume changes that we analyzed for this rule. These volume changes, as detailed in Chapter 3 of the Set 2 RIA, are the starting point for the analyses presented in this document, except where noted.

The No RFS Baseline was derived based on the relative economics of biofuels and the petroleum fuels that those biofuels are blended into. If the blending cost of a biofuel is less than the petroleum fuel that it is blended into (after accounting for all available incentives), we assume that the biofuel would be used and displace the respective petroleum fuel, provided that the fuels distribution system can provide the fuels and vehicles can use those biofuels. The blending cost of a biofuel includes the value that the biofuel has when blending it into the petroleum fuel. There are several components that must be considered for each fuel:

- Production cost
- Distribution cost
- Blending value to the fuel blender (i.e., octane value and RVP cost of ethanol)
- Federal and state subsidies
- Relative energy value of the fuel, which may or may not be a factor
- Cost to upgrade retail stations to enable them to offer the renewable fuel

These various cost components of each renewable fuel are added together to determine the value of each fuel at the point that it is to be blended into petroleum fuel. In the sections below we discuss how this methodology for estimating biofuel volume attributable to the Set 2 Rule below. More details on this methodology can be found in the Set 2 Rule RIA (DRIA (US EPA, 2025C)).

Ethanol

For ethanol, most of the factors contributing to its historical use would continue in the future, even were the RFS program to cease to exist or the EPA to not adopt the Set 2 Rule. In addition, market inertia would likely drive the continued use of ethanol at nearly current levels absent the RFS program, at least in the short term. In the absence of the RFS program, any attempt to reduce the use of ethanol would incur additional costs as refiners would have to change operations (with additional cost) to switch back to producing finished gasoline (E0) rather than blendstocks for oxygenate blending (BOBs) for E10. Furthermore, refiners would have to not only replace the lost volume but also adjust their refining operations to produce gasoline that meets the minimum octane and emissions requirements, without the addition of high octane ethanol. While refiners could likely produce some quantity of E0 gasoline using existing equipment, previous analysis by MathPro conducted on behalf of EPA concluded that if ethanol were removed from the entire conventional gasoline pool, refiners would have to invest significant capital in some combination of alkylation, isomerization, and reforming units to meet the minimum octane requirements for gasoline (US EPA, 2018). There would also be costs associated with making the necessary adjustment to the distribution system to accommodate larger volumes of E0 in a system that is currently oriented towards E10. Given such economic dynamics, we expect that most parties would seek to avoid these additional costs and instead continue supplying E10.

EPA analyses have confirmed that the market would continue supplying E10 in the future even if the RFS program were to cease to exist (US EPA, 2022a). In projecting the No RFS Baseline for the Set 2 rule we used the same methodology as in our previous work but updated the price projections for relevant commodities (gasoline, ethanol, natural gas, etc.) for 2026 and 2027. Conversely, sales and consumption of higher-level ethanol blends, such as E15 and E85, would fall significantly as it is generally not cost effective to market these blends in the absence of the incentives provided by the RFS program. Small volumes of E0 would continue to be produced to meet the demand from, for instance, owners of recreational marine engines whose concerns about engine damage compel them to seek out and pay a premium for ethanol-free gasoline.

We estimate the total volumes of ethanol consumption potentially attributable to the RFS program range from 212–288 million gallons from 2026–2027. However, the total estimated ethanol consumption volumes for 2026–2027 are approximately equal to total ethanol consumption in 2024 and significantly less than total ethanol production in 2024. According to the EIA Monthly Energy Review, U.S. ethanol production in 2024 was 16.22 billion gallons, and ethanol consumption was 14.24 billion gallons. This suggests that the renewable fuel volumes we are finalizing for 2026–2027 could likely be met with little or no additional ethanol production (and thus little to no conversion to cropland resulting from additional ethanol production) relative to 2024 levels.

Table VI.B-1: Volume of Ethanol Consumption Potentially Attributable to the Set 2 Rule

	Total Estimated Ethanol Consumption (mill gal)[a]	Volume of Ethanol in the No RFS baseline (mill gal)	Volume of Ethanol Consumption Potentially Attributable to the RFS Program (mill gal)	Approximate Fraction of Ethanol Consumption Potentially Attributable to the RFS Program
2026	13,783	13,571	212	1.53%
2027	13,662	13,374	288	2.10%

Note: The top-down methodology followed to determine these values likely results in an over-estimate of the volumes of ethanol consumed as E15 and E85.
[a] EPA projection provided in the Set 2 Rule proposal.

Note that a scenario in which the RFS program ceased to exist in the future is not the same as a scenario in which the RFS program had never existed. If the RFS program had not been instituted by EPAct of 2005 it is possible, but not reasonably certain, that ethanol consumption would have risen more slowly or may not have reached a pool-wide average ethanol concentration of 10%, other factors driving ethanol consumption notwithstanding.

Biodiesel

To estimate the effect of the proposed RFS volume requirements for 2026–2027 on soybean and canola production in the U.S., we first estimated the quantity of soybean oil and canola oil that would be used for biofuel production in the absence of the RFS program. We then compared the quantities of soybean oil estimated to be used in the absence of RFS volume requirements in 2026–2027 to the quantity of soybean oil projected to be used to produce biofuels in the U.S. during these years with the RFS volume requirements in place.

While historically biodiesel has generally been more expensive to produce than petroleum-based diesel, in some situations the combination of available federal (non-RFS) and state incentives are sufficient to make the blending of biodiesel profitable despite its higher production costs. In other cases, states have enacted biodiesel use mandates so that minimum quantities of biodiesel must be used regardless of its higher cost.

Our analysis of the volumes of biodiesel and renewable diesel in the No RFS Baseline considered both the production cost of biodiesel and renewable diesel produced from different feedstocks and the cost to distribute these fuels to each state, as well as the incentives available for their use in that state. Where the cost of biodiesel was projected to be lower than the reported cost of diesel fuel, or where there was a state mandate for the use of biodiesel, we projected that biodiesel would be used even in the absence of the RFS volume requirements. In situations where biodiesel costs less to supply than diesel, we projected that consumption of biodiesel in the absence of RFS volume requirements would have been equal to the volume of these fuels used in that state in previous years. In these projections we used price projections from the Energy Information Administration and USDA. We summarize the results of this analysis in the table below.

Table VI.B-2: Estimated Use of Biodiesel and Renewable Diesel Without RFS Incentives (million gallons)

Fuel Type	Feedstock	2026	2027
Biodiesel	Soybean Oil	81	88
	FOG	391	394
	Distillers Corn Oil	90	67
	Canola Oil	27	30
Renewable Diesel	Soybean Oil	0	0
	FOG	1,218	1,290
	Distillers Corn Oil	198	233
	Canola Oil	0	0

After estimating the use of biodiesel in the U.S. in the absence of the RFS volume requirements, we next compared these values to the quantity of soybean oil projected to be used to produce biofuels in the U.S. in 2026–2027. Our projections of soybean oil used for biofuel production in this BE are taken from the projection of fuels used to meet the proposed RFS volume requirements in these years in the Set 2 NPRM. These volumes are summarized in Table VI.A.2-3. Finally, we estimated the impact of the RFS volume requirements from 2026–2027 on the use of soybean oil for biofuel production by taking the difference between the quantity of soybean oil projected to be used for biofuel production and the volumes we estimate would have been or would be used for biofuel production in the absence of the RFS volume requirements. These volumes are summarized in Table VI.B-3.

Table VI.B-3: Domestic Biodiesel and Renewable Diesel Projected to Be Produced from Soybean Oil (million gallons)

	2026	2027
Biodiesel	1,220	1,249
Renewable Diesel	1,294	1,544
Total	2,514	2,793

Table VI.B-3: Volume of Biodiesel from Soybean Oil and Canola Oil Attributable to the Set 2 Rule (million gallons)

	2026			2027		
	No RFS	Set 2 NPRM	Difference	No RFS	Set 2 NPRM	Difference
Soy Biodiesel	81	2,514	2,433	88	2,793	2,705
Canola Biodiesel	27	938	911	30	938	908

C. Projected Impact of the Set 2 Rule on U.S. Cropland

1. Methodology

In the Set 1 BE, the EPA utilized several different methodologies to estimate the potential land use impacts attributable to the Set 1 Rule projected volumes. These methodologies represented the best information and analytical techniques available at the time the Set 1 BE was conducted. When considering the best available data and analytical techniques to project land use change attributable to biofuel production for the Set 2 Rule, the EPA considered the methodologies used in the Set 1 BE as well methodologies that have been conducted since the analyses for the Set 1 BE was completed.

Based on our review of the more recent analyses, the EPA chose to continue with the use of the same methodology from the Set 1 BE for projecting the direct effects of ethanol production on corn planting and total cropland. For canola cropland, we also chose to use the same methodology used in the Set 1 BE in order to project the impact of canola biodiesel on planting and total cropland. Since the completion of the Set 1 BE, however, a new methodology for projecting the direct and indirect effects of soybean biodiesel production on soybean planting and total cropland has been published (Miao et al., 2025). This paper used very similar methodologies to those used by the EPA to project the impacts of ethanol on corn and total cropland in the Set 1 BE. After evaluating this publication, we determined that the methodology published by Miao et al represented an improvement from the methodologies used to project the impact of soybean biodiesel in the Set 1 BE. Notably, the Set 1 methodology used existing data to project the increase in soybean crushing attributable to the Set 1 rule. For this methodology we did not have sufficient data to determine how much of that increased demand for soybeans from crushing facilities would be met by increased domestic soybean production versus reduced soybean exports. This analysis also limited the land reviewed to a large swath of the midwest, where the majority of the land use change is likely to occur. The new methodology for projecting the impacts of increased soybean biodiesel production adopted in this BE removes this geographic restriction of where land use change associated with increased soybean biodiesel production could occur from the Set 1 BE. This section describes the methodologies used to project the impact of biofuel production attributable to the Set 2 Rule on total cropland in the U.S. The results of these methodologies are described in Section VI.C.1, and the primary uncertainties associated with these projects are discussed in Section VI.C.5.

As reviewed in the Third Triennial Report to Congress on Biofuels, the most robust estimate available to date for the effect on corn ethanol production on corn acreage and cropland is from Li et al (2019). This study, like many others, analyzes the direct impact of corn land use and total cropland based on the proximity to an ethanol plant. However, Li et al. (2019) not only conducts a direct land use assessment but also an assessment of indirect land use effects. This indirect assessment examines the effect that changing crop prices have on land use. Li et al (2019) is the only study available to date using this method of looking at empirical data that explicitly separated the price effect from the direct effect of ethanol on the estimates of land use change.

For the direct effect portion of this analysis. Li et al. (2019) identifies the effects of ethanol plant proximity and of crop prices on cropland acreage over the 2003–2014 period. The study states that the effect of proximity to an ethanol plant on corn acreage is likely to be most evident in the vicinity of the plant because it can pay a higher price to a farmer net of transportation costs than does a distant terminal market. Unlike other studies which examine the proximity of land use to ethanol plants, Li et al. (2019) reviewed this correlation on a national scope rather than on a specific region.

Indirect effects from crop prices on cropland are not as heavily studied as the direct effects. This study in particular addresses not just one region but the nation as a whole. Unlike the effects of ethanol plant proximity, the effect of an increase in crop prices on cropland acreage is expected to be more widespread and not confined to the vicinity of the plants. By enhancing returns from corn production at all locations, an increase in corn price creates incentives to convert land from other uses to corn, both in the vicinity of ethanol plants and distant from the plants. Higher prices for corn can also result in higher prices for other crops that compete with corn for arable land. In their empirical analysis Li et al. (2019) also investigate the omitted variable bias by estimating specifications that include or exclude crop prices and by analyzing its implication for the coefficient of the ethanol capacity variable.

However, as important as the Li et al. (2019) study has been to understand the impacts of the RFS program on land use, several factors limit the utility of this study in projecting the impact of the Set 2 Rule on land use in 2026 and 2027. First, the Li et al. (2019) study used data from 2003–2014 to examine how changes to corn acreage and crop acreage were affected by proximity to ethanol plants. While we believe the methods used in this study remain sound, it is important to consider more recent data to produce the best available projection if land use impacts attributable to the Set 2 Rule. Second, the Li et al. (2019) study only assessed the impact of ethanol production on corn planting and total cropland. With the increasing importance of soybean biodiesel, it is important to use the best methods available to project the expected impacts of increasing soybean biodiesel production to fully evaluate the potential impacts of the Set 2 rule.

In effort to improve our analysis for the Set 2 Rule, the EPA contracted with the same research team that conducted work on the Set 1 rule to update the analysis described above. This new analysis compares estimates of the effect of ethanol plant proximity and crop prices on land use change in the United States using more current data (Khanna, 2025). This study extends the Li et al. evaluation to cover the period of 2003–2023, providing an analysis with more recent data. Extending the Li et al. (2019) study allowed for a comparison of estimates of the effect of ethanol plant proximity and crop prices on land use change within the updated timeframe. It also examined whether the effect of ethanol production capacity on corn acreage and total crop acreage varied during this extended period. This new report examined these effects of ethanol production using both a balanced panel and an unbalanced panel of counties that reported corn acreage and total acreage data over this period. Additionally, it used both a 25-mile radius and a 50-mile radius around an ethanol plant to construct effective ethanol capacity to examine its effect on crop acreage at varying distances from the plant. Due to data limitations, the updated analysis relies on quantifying the effects of ethanol plant capacity (rather than actual ethanol production) on crop acreage.

Separately, EPA also worked with the same research team to adapt the methodology first developed in the Li et al. (2019) paper to estimate the impact of soybean biodiesel production on soybean planting and total cropland. Modifications of the methodology developed to estimate the impact of ethanol production were necessary due to differences in the way crops are used to produce biofuels between corn used for ethanol production and soybeans (and other oilseeds) used for biodiesel production. The key difference between these production processes is that while corn is directly delivered to ethanol plants, soybean biodiesel production facilities use soybean oil rather than soybeans as their primary feedstock. Soybeans must therefore be processed at a crushing facility to produce soybean oil before the oil can be shipped to biofuel production facilities for fuel production. This means that to the degree that soybean biofuels cause land use change, this land use change will be unlikely to occur in the proximity of a biorefinery. Instead, any direct increase in soybean planting caused by soybean biodiesel production would be expected to occur closer to soybean crushing facilities.

To assess the impact of soybean biodiesel production on land use near soybean crushing facilities the research team acquired proprietary data at the facility level for soybean crushing facilities. This data allowed for further analysis of the correlation of biofuels on crush facilities and effects on cropland. Using a similar methodology as first developed in the Li et al. (2019) paper, the research team used data from 2011–2020 (years where soybean oil to biodiesel production had increased significantly from previous years) to estimate the impact of soybean biodiesel production on land use change. Additionally, the research team also analyzed the impact of increasing soybean prices on cropland. The results of this analysis were published in *Applied Economic Perspectives and Policy* in July 2025 (Miao et al., 2025). In this BE we used the factors developed by Miao et al., together with the estimates of the volume of soybean biodiesel attributable to the Set 2 Rule described in Section VI.B, to project the direct impacts of soybean biodiesel on soybean planting and total cropland.

Ideally, we would have used this same methodology to project the impacts of canola biodiesel attributable to 2026 and 2027. However, as discussed in Section VI.A.3, much of the canola used to produce biofuel in the U.S. is imported rather than produced domestically.

Further, the limited quantities of canola oil that are produced in the U.S. in some cases are produced from imported canola seed. The heavy reliance on imported products in the case of canola oil would likely require the development of new analytical techniques to reliably project the impact of increased canola biofuel in listed species in the U.S. The development of these methods would likely be further complicated by the fact that the EPA does not always have access to detailed data on canola seed and canola production in other countries that would strengthen such an analysis. In the absence of a new methodology to project the impact of canola biodiesel on land use in the U.S. for this BE we have relied on the same methodology as in the Set 1 BE. This methodology, described in greater detail in Section VI.C.2.c, used the FASOM model to project land use changes attributable to an increase in demand for canola biodiesel. We scaled these impacts of this modeling based on the volume of canola biodiesel attributable to the Set 2 Rule relative to the increase in demand for canola biodiesel in the original FASOM modeling.

Based on empirical data the methodology developed by Li et al. (2019) estimated the increase in total cropland for every dollar increase on the crop price index. The crop price index is an average of the prices for the top 10 commodity crops produced in the U.S., weighted by the total production of each crop. To use these factors to project total cropland attributable to the Set 2 Rule we had to estimate the impact of the biofuel volumes attributable to the Set 2 Rule on the crop price index. As discussed in greater detail in Section VI.C.3, we considered estimates of the impacts of the Set 2 volumes on crop prices from multiple models. These estimates of the impact on crop prices allowed us to calculate a projected change in the crop price index attributable to the Set 2 Rule, which together with the factors developed by RTI and Khanna (2025) are the basis for our projections of the indirect effects of the Set 2 Rule on total cropland in this BE.

2. Direct Effects

a. Direct Effects of Corn Ethanol Production

As reviewed in the Draft Third Triennial Report to Congress on Biofuels, the most robust estimate available to date for the effect on corn ethanol production on corn acreage and cropland is from Li et al. (2019). This is the only study available to date using empirical data that explicitly separated the price effect from the ethanol effect on the estimates of land use change. Li et al. (2019) analyzed historical data to estimate the impact that a change in ethanol production volume might have on acres of corn or total crops planted (Li et al., 2019).

The 2019 Li et al. study used data from 2003–2014 to examine how changes to corn acreage and crop acreage were affected by proximity to ethanol plants. EPA contracted with RTI to expand the analysis of the impact of ethanol production on corn planting and total cropland using data through 2023 and the same methodology as the 2019 Li et al. paper (Khanna, 2025). This more recent evaluation found that the estimates of the impact of ethanol production on corn planting and total cropland in the vicinity of ethanol plants varied for different time periods. The estimates based on Khanna (2025) are that each billion gallons of corn ethanol increases cropland by 0.363 million acres in 2026–2027. The results from Khanna (2025) imply that during the earlier years evaluated, crop acreage was more affected by the proximity to ethanol plants. Years with more recent data (post 2019) indicate that ethanol capacity may be diverging as an indicator for ethanol production. In the 2003–2017 timeframe, the estimates of average acres needed per unit of ethanol in the regressions from Khanna (2025) converge which indicates this data is the most representative for our evaluation.

Based on the factors from the updated Khanna analysis and the volume of ethanol attributable to the Set 2 Rule in 2026 and 2027, we estimate the ethanol volumes potentially attributable to the RFS program would have the corn acreage and total cropland (i.e., changes in cropland for other crops caused by the changes in corn) impacts shown below.

Table VI.C.2.a: Estimated Impact on Corn Acreage Using Factors Derived by EPA

	Volume of Ethanol Consumption Attributable to the RFS Program (mill gal)[a]	Corn Acreage Factor (mill acres/bil gal)	Corn Cropland (million acres)
			Through Ethanol Volumes
2026	212	0.363	0.075
2027	228	0.363	0.081

[a] From Table VI.B-5.

Table VI.C.2.b: Estimated Impact on Cropland Acreage Using Factors Derived by EPA

	Volume of Ethanol Consumption Attributable to the RFS Program (mill gal)[a]	Cropland Acreage Factor (mill acres/bil gal)	Cropland (million acres) Through Ethanol Volumes
2026	212	0.442	0.094
2027	228	0.442	0.101

[a] From Table VI.B-5.

Similar to the analysis on corn acreage described above, total cropland had several evaluations done on the data. The same years of 2003–2017 represent the best estimates for our analysis as the model's regression begins to diverge in Khanna's study after this timeframe.

Based on the data above, it appears that an increase in corn cropland is possible with the increase in volumes attributable to this rule. This increase could mean that a potential displacement of existing crops could occur. In order to be conservative for the EPA's total cropland estimates, the cropland acreage will be utilized in that evaluation.

b. Direct Effects of Biodiesel from Soybean Oil

Since the analyses for the Set 1 BE were completed, new research has been published estimating the impact of soybean biodiesel production on soybean acreage and total cropland (Miao et al., 2025). This analysis used similar methodology as the 2019 Li et al. paper and was conducted using data covering 2010–2020. This biodiesel[17] analysis was in part parameterized with new proprietary information from CrushTraders, who provided soybean crush data necessary to estimate the direct effects of soybean biodiesel production on soybean acreage and total cropland in the vicinity of soybean crushing facilities. This paper estimated an increase of 1.93 million acres of soybeans and 0.96 million acres of total cropland for each billion gallons of soybean biodiesel production in 2026–2027.

Based on this analysis and the volumes of soybean biodiesel attributable to the Set 2 Rule in 2026 and 2027, we estimate the biodiesel volumes potentially attributable to the RFS program would have the cropland impacts shown below.

[17] Note that references to "soy biodiesel" and "canola biodiesel" will encompass both biodiesel and renewable diesel.

Table VI.C.2.b-1: Estimated Impact on Soy Acreage Using Factors Derived by the EPA

	Volume of Biodiesel Consumption Attributable to the RFS Program (mill gal)[a]	Soy Acreage Factor(mill acres/bil gal)	Soy Cropland (million acres)
			Through Biodiesel Volumes
2026	2,433	1.93	4.696
2027	2,705	1.93	5.221

[a] From Table VI.B-5.

Table VI.C.2.b-2: Estimated Impact on Cropland Acreage Using Factors Derived by the EPA

	Volume of Biodiesel Consumption Attributable to the RFS Program (mill gal)[a]	Cropland Acreage Factor (mill acres/ bil gal)	Cropland (million acres)
			Through Biodiesel Volumes
2026	2,433	0.96	2.336
2027	2,705	0.96	2.597

[a] From Table VI.B-5.

c. Direct Effects of Biodiesel from Canola Oil

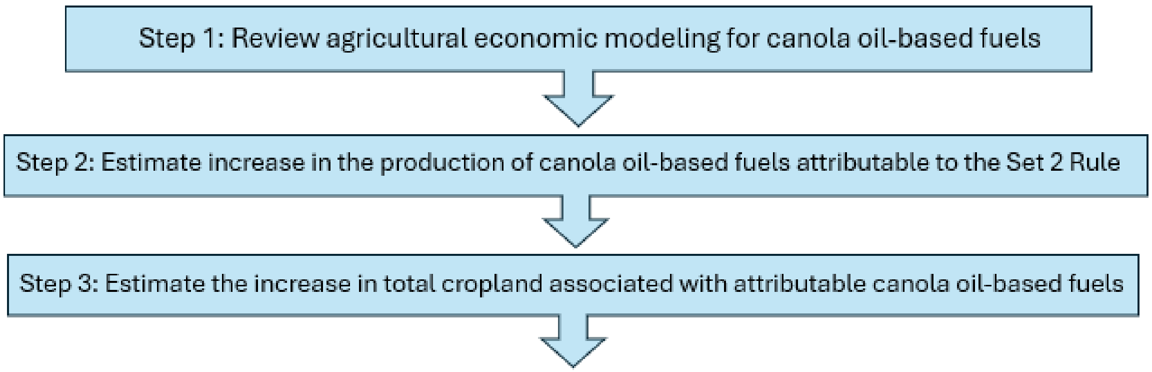
While the EPA was able to use published methodologies based on empirical data that separately estimate the direct and indirect effects of ethanol production and soybean biodiesel production on land use change, no comparable methodologies are available for estimating the impact of canola biodiesel production in the U.S. In the absence of better methodologies we are continuing to use the same methodology as in the Set 1 BE to project the impacts of canola biodiesel on land use change. This methodology is based on an analysis conducted by EPA in the context of a 2022 final rulemaking (FRM) in response to an RFS pathway petition from the U.S. Canola Association (USCA) to add canola oil-based pathways[18] to the program. This analysis was described in detail in the notice of proposed rulemaking (NPRM) (*87 FR 22823*, 2022) and summarized in the subsequent FRM (*87 FR 73956*, 2022).

This analysis was primarily comprised of agricultural economic modeling and included estimates of the U.S. cropland and other land cover changes which might result from an increase in U.S. consumption of canola oil-based fuels. As in the Set 1 BE, we combined this analysis with our projection of the volume of canola oil-based fuels attributable to the Set 2 Rule in 2026 and 2027. Through the combination of these two analyses, we derived an estimate of the cropland impact of the use of canola oil-based fuels potentially attributable to the RFS program.

[18] As described in Table 1 of 40 CFR 80.1426, a renewable fuel pathway is defined for the purposes of the RFS program as a unique combination of three essential characteristics: a feedstock (e.g., corn starch, soybean oil, canola oil), a fuel production process (e.g., fermentation, transesterification, hydrotreating), and a finished fuel (e.g., ethanol, biodiesel, renewable diesel).

Figure VI.C.2-1 illustrates the steps we used to estimate the increase in total cropland due to the increased consumption of canola oil-based fuels potentially attributable to the Set 1 Rule.

Figure VI.C.2-1: Process for Estimating Impacts of Canola Oil-Based Fuels on Total Cropland in the U.S.



In the canola oil-based fuel pathways FRM described above, the EPA used the same biofuel lifecycle analysis methodology and modeling framework developed for the March 2010 RFS2 rule (*75 FR 14670*, 2010) and that was subsequently used for the September 2010 Canola Oil Rule (*75 FR 59622*, 2010).[19] The components of this methodology relevant to the present BE involve the use of domestic agricultural modeling to estimate emissions from land use change, crop production, and livestock in the U.S. This methodology was developed to estimate "lifecycle greenhouse gas emissions" as defined at section 211(*o*)(1)(H) of the Clean Air Act. It was used for the March 2010 RFS2 rule after an extensive peer review and public comment process.

The 2022 canola oil-based pathway determination relied on this methodology, using the Forest and Agricultural Sector Optimization Model with Greenhouse Gases model (FASOM). The assessment supporting this pathway estimated canola oil imports would increase by approximately 40 percent in 2022 in response to the shock. Because modeled non-fuel uses of canola oil are not drawn on as significantly to provide feedstock for this shock, FASOM does not estimate there would be a significant need to backfill the domestic U.S. vegetable oil market. Domestic consumption of other vegetable oils therefore does not change significantly in these results.

Based on those results, the Set 1 Rule canola analysis for the BE estimated the increase in canola oil production would result in an increase in canola seed crushing of approximately 253.5 million pounds, an increase in domestic canola oil production of about 7 percent compared to the Control Case. Most of this increase in canola crushing would be supplied through increased imports of whole canola seed. Of the total increase in canola seed supply to the crushing market,

[19] For information about our 2010 methodology and analysis see Section 2 of the regulatory impact analysis (RIA) for the March 2010 RFS2 rule and the associated lifecycle results (Docket Item No. EPA-HQ-OAR-2005-0161-3173).

87 percent was estimated to come from increased imports and 13 percent was estimated to come from increased domestic U.S. production. The U.S. canola product markets are historically import-dependent. Based on this, we believe the response in FASOM is consistent with historical market patterns. However, FASOM estimated the increase in domestic crushing would also induce a response from domestic canola seed demands. FASOM estimated direct domestic uses of canola seed other than crushing would decrease by approximately 16 percent. Domestic canola seed production also responds, and FASOM estimates domestic production would increase by approximately 1 percent. This increase in U.S. canola seed production would be facilitated in part by a modeled expansion in canola harvested crop area of about 17,600 acres, or about 1.2 percent, in the U.S. in 2022.

These shifts in canola supply, demand, and trade would also have implications for production and consumption of other crops. The modeled increase in canola crushing also produced an additional 156 million pounds of canola meal, all of which FASOM estimates would be supplied to the domestic livestock market. This influx of meal would primarily displace corn in livestock diets. Corn consumption in the domestic feed market was therefore estimated to decrease by about 306 million pounds (about 0.08 percent). This same dynamic can be observed in the FASOM results for commodity trade. As international trade partners increase exports of canola oil to the U.S., these exporters crush additional canola seed. This creates additional supplies of meal for these canola-producing nations, reducing their demands for corn as well.

Note that, as described further below in this section, we did not consider any of FASOM's estimated decreases in crop area when estimating the impacts on endangered species for the Set 1 BE. This is a very conservative assumption which likely led to an overstatement in the nationwide crop area impact of canola oil-based fuels on endangered species. However, as described elsewhere in the Set 1 BE evaluation, canola oil-based fuels and corn-based fuels may both expand production under Set rule volume standards. We believe ignoring the decline in corn area projected by FASOM improves alignment between our canola analysis and our corn analysis, where corn area increases within the study area. Therefore, while it led to a very conservative estimate of nationwide crop area expansion attributable to canola oil, we believe it improved the overall scientific robustness of our findings with respect to potential impacts on endangered species. We are taking the same approach in the Set 2 BE to remain consistent with our prior analyses.

Canola and wheat can be produced on the same type of land in high latitude agricultural systems like Canada and North Dakota, and many farmers rotate the two crops. In response to an increase in production of canola, farmers are likely to respond in one of two ways. One option is that total acres in wheat/canola rotation could increase. The other option is for canola to displace wheat area to some extent as farmers tilt rotations more heavily towards the former (e.g., canola-canola rotations rather than canola-wheat rotations). Geographically, the modeled domestic response to the shock was concentrated in North Dakota to reflect these changes. As North Dakota is the dominant producer of canola in the U.S., this modeled impact appears to be consistent with historical agricultural patterns. North Dakota is also a significant producer of wheat. As canola production is estimated to expand in North Dakota, FASOM estimated wheat production would shift to North Dakota region by about 218 million pounds, decreasing on net in all other regions by about 50 million pounds.

Canola is generally crushed near areas of cultivation and a majority of U.S. facilities that process canola seed are located in North Dakota (National Oilseed Processors Association, n.d.). Following this, as North Dakota canola production is estimated to expand to supply the canola shock, FASOM estimated the additional seed would be crushed into oil and meal in this region as well. This would expand regional supply of livestock feed and would decrease regional feed prices, relative to other regions of the U.S. FASOM estimates that this, in turn, would create incentives to shift livestock production to North Dakota and nearby states. Since livestock feed mixes require several different components, FASOM estimates this shift in livestock production towards North Dakota would also shift production of other feed crops (e.g., corn, soybeans, hay) into North Dakota.

While much of this section has focused on the original analysis performed for canola in the Set 1 Rule BE to provide context and a history of past RFS actions, many of the same modeling impacts and drivers are similar for the 2026–2027 period. The methodology used for this evaluation for the Set 2 Rule differs in that canola impacts are now integrated with corn and soy, and we focused on a larger U.S. continuous area as opposed to just North Dakotan impacts. The new analysis is also adjusted for the new canola projected volumes in the Set 2 Rule. However, the model interactions for canola and the broad drivers on other markets and crops remain consistent in the models used in the new methodology for the Set 2 Rule. We used the same general procedures for identifying potential locations of acreage impacts from increased canola production as was used for identifying locations of acres impacted from increased corn production in the Set 1 Rule. For further details of that analysis, see Section VII.A of the Set 1 BE, although relevant details are summarized here (US EPA, 2023b). In the Set 2 Rule BE, our methodology for the canola direct impacts has followed the same framework as for the Set 1 Rule BE but is scaled to the new volumes. However, the Set 2 Rule analysis uses a different approach to quantify indirect canola impacts, as that analysis is now integrated with corn and soy.

In the Set 1 BE, using the results from the 2022 canola oil-based pathway analysis based on the FASOM, we evaluated a hypothetical canola oil demand shock scenario to estimate changes in domestic agricultural production, trade, and land use and associated GHG emissions associated with the biofuel pathway under consideration. In this demand shock scenario, U.S. domestic consumption of a specific biofuel pathway is assumed to increase by some amount relative to the volume of U.S. domestic consumption in a reference scenario.

In the modeling supporting the 2022 canola oil-based pathway, the EPA conducted two modeling scenarios in FASOM for this analysis.[20] The difference in GHG emissions between these two scenarios represents our estimate of the emissions from land use change, agricultural input, livestock, and other agricultural sector impacts associated with using canola oil as a biofuel feedstock. First, we ran an updated Control Case that reflected the updated assumptions

[20] Complete sets of results for these FASOM modeling scenarios are available on the docket for the rulemaking they were conducted for: EPA-HQ-OAR-2021-0845.

for global canola oil production, yields, and trade.[21] In this Control Case, we assumed no canola oil-based biofuels were consumed in the U.S. Second, we conducted a shock scenario that assumed a 1.53 billion pound increase in canola oil production for use as feedstock to produce approximately 200 million gallons of canola oil-based fuels for U.S. consumption of in 2022 (hereafter the "Canola Case"), which was assumed to ramp up linearly from 2012–2022 (see Table VI.C.2.c-1).[22] According to USDA historical data, annual U.S. consumption of canola oil ranged from about 5.3 to 6.4 billion pounds over the period between 2015 and 2020 (USDA Economic Research Service, 2025b). In addition, global canola/rapeseed seed annual exports ranged from approximately 32 to 38 billion pounds between 2015 and 2020 and canola/rapeseed oil exports ranged from about 9 to 13 billion pounds over the same period; this suggests substantial quantities of additional feedstock may be available for import to the U.S. market (USDA Foreign Agriculture Service, n.d.). Based on data from EPA's Moderated Transaction System (EMTS), the U.S. produced approximately 160 million gallons of canola oil biodiesel in 2020, and another 123 million gallons of biodiesel produced from a mix of feedstocks were imported from Canada, which likely included a portion from canola oil. Thus, the volume of hydrotreated canola oil-based fuels in the modeled shock was of a similar order of magnitude as the volume of biodiesel produced from canola oil at the time the analysis was conducted. The structure of this shock was designed to be consistent with the shock methodology approach used for the EPA's previous lifecycle GHG analyses of agricultural feedstocks under the RFS program.

Table VI.C.2.c-1: Canola Oil Shock Scenario

Year	Assumed Increase in USA Canola Oil Consumption for Biodiesel Production (Billion Pounds of Canola Oil)
2012	0.25
2017	0.9
2022–2057	1.53

Note: Consistent with our existing methodology, the volume shock is implemented slightly differently in FASOM and FAPRI. For FASOM, which operates in 5-year time steps, the values in this table fully represent the assumptions used to implement the shock. For FAPRI, which operates in annual time steps, interim year assumption values are interpolated linearly to create a smooth "ramp-up" path for the volume shock. Further description of this methodology can be found in Chapter 2 of the Final Regulatory Impact Analysis associated with the March 2010 RFS2 rule (EPA-420-R-10-006).

The EPA used FASOM to estimate, among other impacts, domestic land use change associated with using canola oil as a biofuel feedstock. In the Set 1 Rule BE, we described the ways in which FASOM estimates the canola oil feedstock used to supply the biofuel shock would be sourced and then the market adjustments in canola oil prices, supply, demand, and trade which FASOM estimates would be necessary to facilitate this sourcing of canola oil for fuel use. Following this, we described the shifts in production of other crops, cropland use, and land use which FASOM estimates would occur as a result of the sourcing of canola oil for fuel use.

[21] A memorandum describing these updates and referencing their sources is available on the docket EPA-HQ-OAR-2021-0845.

[22] Depending on the source of hydrotreating process data used, the size of the shock ranges from 187 million gallons of hydrotreated renewable fuel (based on GREET-2021) to 220 million gallons (based on data in petitions submitted pursuant to 40 CFR 80.1416 claimed as confidential business information).

This analysis integrated direct and indirect effects on total cropland as a result of increased canola production attributable to the Set 1 Rule. The analysis we have done for the Set 2 Rule similarly estimates indirect effects on total cropland from canola production, as described in the following sections, with modeling efforts and a combination of all three feedstock analyses. However, for direct effects of canola attributable to the Set 2 Rule, we have followed the same methodology as was used for direct effects in the Set 1 Rule analysis.

The FASOM modeling supporting the 2022 canola oil-based pathways found that approximately 305 acres of domestic land use change was attributable to one million gallons of canola oil production (US EPA, 2022c). The quantity of canola oil-based biofuel production we project will be attributable to the Set 2 rule are 911 million gallons for 2026 and 908 million gallons for 2027. At 305 acres/million gallon of canola oil, the 2026 volume of 911 million gallons works out to 277,855 acres of land use change from canola, or 0.278 million acres. Similarly, at 908 million gallons in 2027, the direct land use change attributable to domestic canola oil production is predicted to be 0.276 million acres. These results are summarized in the table below.

Table VI.C.2.c-2: Estimated Impact on Cropland Acreage Using Factors Derived by EPA

	Volume of Canola Consumption Attributable to the RFS Program (mill gal)[a]	Cropland Acreage Factor (acres/mill gal)	Cropland (million acres)
			Through Canola Volumes
2026	911	305	0.278
2027	908	305	0.276

[a] From Table VI.B-5.

3. Indirect Effects

In the previous BE, the EPA utilized several different methodologies to analyze potential land use change for each crop. While the methodology used to project the impacts of increasing ethanol production enabled us to separately project direct and indirect effects, the methodologies used to project the impacts of increasing soybean and canola biodiesel did not. The use of a recently published methodology (Miao et al. 2025) for projecting the impact of soybean oil biodiesel using empirical data that closely resembles the methodology used to project the impacts of ethanol production in the BE for this rule enables us to separately project direct and indirect effects for both ethanol and soybean biodiesel production.

While we still do not have a methodology for separately projecting the direct and indirect effects of canola biodiesel production, the methodology used to project the indirect effects of ethanol and soybean biodiesel (described below) can be extended to project the indirect effects of canola biodiesel production. Because the methodology used to project the impacts of canola biodiesel (described in Section VI.C.2.c) covers both the direct and indirect effects, using a separate methodology to project the indirect effects of all three crop-based biofuels attributable to the Set 2 Rrule is a conservative approach, as it effectively double counts the indirect effects of canola biofuel. Nevertheless, we believe using this approach is appropriate, if conservative, for this BE as it enables us to use a consistent and recently updated approach to projecting the indirect effects of all three types of biofuel.[23]

The methodology developed by Li et al. in 2019 does not directly estimate the indirect effects of ethanol production on total cropland. Rather, this methodology estimates the price elasticity of aggregate or total cropland (e.g. the increase in total cropland expected to result from an increase in the price for agricultural crops). The price elasticity of total cropland can then be used with projections of the impact of higher biofuel production attributable to the Set 2 rule on crop prices to project the impact of attributable biofuels on total cropland.

For the Set 1 BE, because we were only projecting the indirect impacts of corn ethanol (rather than all biofuels) on total cropland we used an estimate of the impact of corn ethanol production on crop prices from published literature (Robert and Schlenkler 2013). However, in this BE we are projecting the indirect effects of all biofuels on total cropland (not just ethanol) and therefore we need an estimate of the aggregate impact of all biofuels production attributable to the Set 2 Rule on crop prices. While there are several estimates of the impacts of biofuel production on crop prices for individual biofuels, we are not aware of any public estimates of the impact of the biofuel volumes attributable to the Set 2 Rule on crop prices. We believe that projecting the price impacts of these biofuels in aggregate, rather than separately projecting the impacts of each biofuel type and combining the impacts, produces a better projection of the overall impact on crop prices. Aggregate estimates of price impacts reflect interactions such as the competition between different crops for arable land that would likely be unaccounted for when projecting the impacts of individual biofuels (e.g. corn ethanol, soybean biodiesel, etc.) separately.

In the Draft Regulatory Impact Analysis (US EPA, 2025c) for the Set 2 proposed rule the EPA assessed the impacts of multiple scenarios on a variety of factors using global economic models. The models used in the Set 2 Draft Regulatory Impact Analysis are:

- Global Change Analysis Model (GCAM) – A partial equilibrium, multisector dynamic model that operates in five-year increments and can be used to examine how alternative trajectories in population, income, and technology adoption may affect a broad array of human and earth systems such as agricultural production, energy demand, and regional water resources (Joint Global Change Research Institute, 2025).
- Global Biosphere Management Model (GLOBIOM) – A partial equilibrium, recursive dynamic model that operates in 10-year increments with detailed grid cell land representation that captures the agricultural, forest and bioenergy sectors. (Integrated Biospheres Futures, International Institute for Applied Systems Analysis, 2023).

[23] We also note that we expect that the double counting of the indirect effects of canola biodiesel will have a relatively small impact on our overall projection of the land use change attributable to the Set 2 rule, both because the total attributable quantity of canola biodiesel is smaller than the combined volume of attributable ethanol and soybean biodiesel and because (consistent with the FASOM modeling and relatively high proportion of canola oil that is imported) we expect that most of the indirect effects of increasing canola biodiesel production would occur outside the U.S.

From each of these models, we compute a Laspeyres price index using a selected subset of crops, aligning, to the extent possible, with the list of crops for which the USDA publishes projections in their "Agricultural Projections to 2033", which we used for other purposes in our land use change calculations. The crop categories used in the price index calculation are presented alongside the comparable crop from USDA's Agricultural Projections in Table VI.C.3-1 below.

Table VI.C.3-1: Crop List Utilized for Total Cropland Price Index Calculation

Model Crop List	USDA Crop List[a]
Corn	Corn
Other Grains	Sorghum / Barley / Oats
Rice	Rice
Soybean	Soybeans
Wheat	Wheat

[a] Note that the USDA projections also include "Upland Cotton." In the data available from the GCAM and GLOBIOM, cotton production and prices were reported under and aggregate "Other Crops" category, combined with many other agricultural products with different masses and prices. For this reason, we have excluded cotton from the price index calculation conducted in this analysis.

Laspeyres indices are commonly used in published consumer price indices and use quantities in a defined base year to weight prices in future time periods. In the GCAM and GLOBIOM modeling conducted for the Set 2 proposed rule, consumption of crop-based biofuels in model year 2030 was constrained to match the 2028 volume targets in the "High Volume" and "No RFS Baseline" scenarios. Thus, crop price impacts in model year 2030 represent the estimated price impacts of volumes changing to the targets specified in these respective scenarios. In order to characterize the indexed price effect of changing volumes, we use as a base year in the Laspeyres index calculation the most recent model year in the scenarios in which the "High Volume" and "No RFS Baseline" scenarios had aligned biofuel volumes. Because GLOBIOM operates in 10-year timesteps and GCAM operates in five-year timesteps, the base years for the index calculated from GLOBIOM and GCAM are 2020 and 2025 respectively.

In order to assess the impacts of setting RFS volume standards relative to the no RFS baseline scenario, we calculate the percent difference in crop price index between the two scenarios in model year 2030. These values, however, represent the price impacts under the "High Volume" scenario—an analytical scenario conducted for the proposed rule—in 2028. In order to assess the impacts under the proposed volume standards in 2027, we scale this percent difference in prices by the ratio in the 2027 proposed volumes to the 2028 "High Volumes" (crop-based fuels only). This scaling factor is 0.92 and is discussed in more detail in DRIA Chapter 5. The resulting crop price indices, percent differences, and scaled percent differences are presented in Table VI.C.3-2 below.

Table VI.C.3-2 Crop price impacts estimated using GCAM and GLOBIOM modeling conducted for the proposed rule

	Crop Price (Laspeyres) Index

Model	No RFS Baseline	High Volume Scenario	Scenario Difference	Percent Difference	Scaled Percent Difference
GCAM	98.27	99.37	1.10	1.12%	1.03%
GLOBIOM	96.21	98.26	2.05	2.13%	1.96%

Note that, across the selected subset of crops, GLOBIOM shows roughly double the crop price responsiveness compared to GCAM. This may be due to greater restrictions on land conversion in the USA in GLOBIOM; such constraints in models may force less economically efficient, and therefore more expensive, outcomes. The percent changes were input into the Li et al. (2019) calculation used for the direct land use change calculation for soybean and corn described in the Methodology section.

Table VI.C.3-3: Indirect Cropland Change Estimates Using GCAM and GLOBIOM to Estimate CPI

	2026		2027	
	Crop Price Index Percentage Difference	Estimated Acres (mil)	Crop Price	Estimated Acres (mil)
Indirect (GCAM)	1.03%	0.381	1.03%	0.381
Indirect (GLOBIOM)	1.96%	0.725	1.96%	0.725

The tables above show the calculations for the total cropland with a CPI from both GCAM and GLOBIOM. Both estimates represent reasonable projections of acreage potentially effected by land use change due to the Set 2 Rule volumes. However, it should be noted that the GLOBIOM estimate is roughly double that of the GCAM estimates. This is due to constraints found in the GLOBIOM model on conversion of natural lands within the USA.

4. Total Estimated Cropland Impacts

After estimating both the direct and indirect impacts of potential land use changes from non-cropland to cropland that could result from increased demand for each of the three biofuel feedstocks—corn, soybean oil, and canola oil—we then considered the potential cumulative impacts for all three combined. It is these cumulative impacts, rather than the expected impacts from increased demand for corn, soybean oil, and canola oil individually (discussed in Sections VI.A–VI.C), along with the water quality impacts (discussed in Section VIII), that must be considered to understand potential impacts on listed species. These potential cumulative impacts, however, do not fully account for how the direct effects of individual acreage assessments from increases in corn ethanol, soybean oil, and canola oil as described in Sections VI.A-VI.C interact with one another. For example, as described in Section VI.C, the results from economic modeling suggests that total acreage for corn cropland could actually decrease due to increases in canola oil. We do not account for this potential decrease in assessing the cumulative impacts.

Table VI.C.4-1: Total Cropland Estimates Using GCAM (million acres)

Cropland	2026	2027
Corn – Direct	0.094	0.101
Soy – Direct	2.335	2.596
Canola – Direct	0.278	0.276
Total Cropland – Indirect	0.381	0.381
Total	3.088	3.354

Table VI.C.4-2: Total Cropland Estimates Using GLOBIOM (million acres)

Cropland	2026	2027
Corn – Direct	0.094	0.101
Soy – Direct	2.335	2.596
Canola – Direct	0.278	0.276
Total Cropland – Indirect	0.725	0.725
Total	3.432	3.698

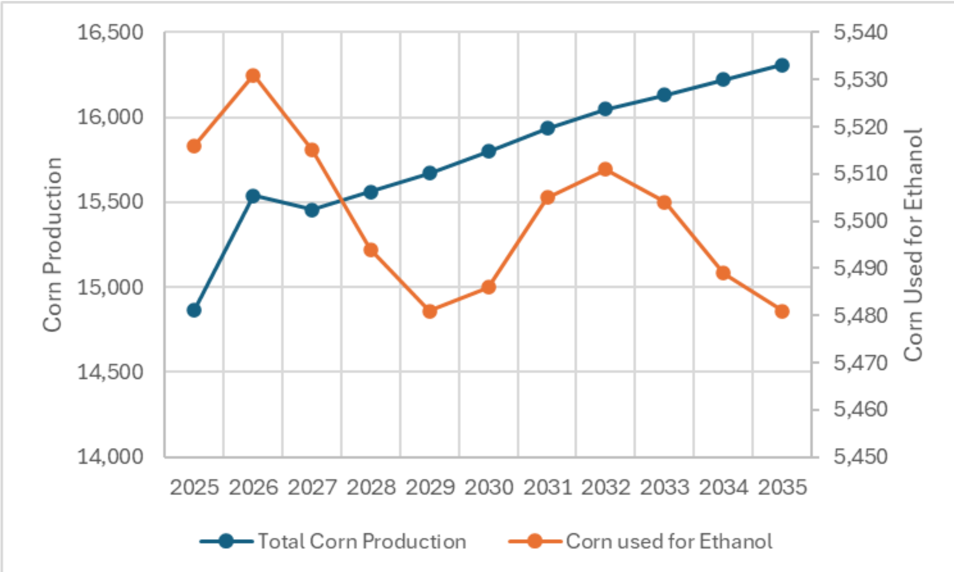
5. Uncertainties in the Land Use Change Estimates

Sections VI.C.1-4 describe the methodologies used to project the impact of the renewable fuel volumes attributable to the Set 2 Rule in 2026 and 2027 on land use change. This section discusses some of the uncertainties associated with these land use change projections. While we have used the best available data and methodologies, there remain significant uncertainties related to our projections in land use change attributable to the Set 2 Rule.

Corn

Despite the corn and total cropland acreage that may be attributable to the RFS program as shown in Table VI.C.4-2a and VI.C.4-2b, we note that future increases in total corn production may be driven by demand for corn used for non-ethanol purposes. The University of Missouri's "U.S. Agricultural Market Outlook" projects that total corn production will increase through 2035 (FAPRI, 2025). However, that increase is projected to be predominately the result of increases in demand for corn for non-ethanol purposes. Increases in the use of corn to produce ethanol is projected to be a considerably smaller portion of the total increase in corn production.

Figure VI.C.5-1: Corn Projections From 2015–2035 (million bushels)



Source: Food and Agricultural Policy Research Institute.

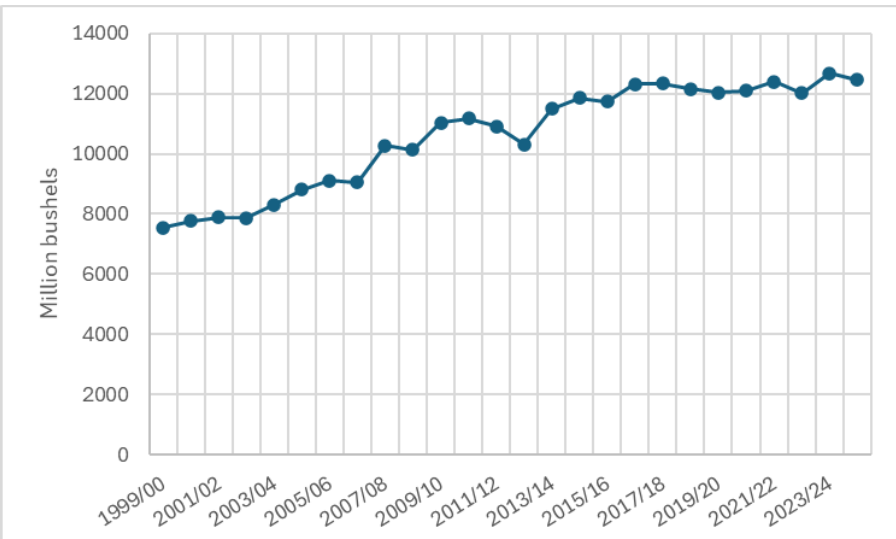
Total corn production is projected to increase steadily after 2027. However, over this time frame corn production for ethanol is projected to stay fairly constant with minimal fluctuations per year. This result indicates that the demand for non-ethanol uses of corn is anticipated to increase at a considerably faster rate than the demand for corn used to produce ethanol. While this result does not change the fact that some corn production can be attributed to the RFS program, it does indicate that any incremental impact on cropland used to grow corn for the purposes of producing ethanol would be small in comparison with increases in corn cropland for non-ethanol purposes. Consequently, corn production that may be attributable to the RFS program may not be meaningfully measurable or observable.

While we estimate that the Set 2 Rule may be responsible for as much as 1-2% of ethanol consumption in the 2026–2027 timeframe as shown in Table VI.B-1, this ethanol volume would correspond to about 1% of the land devoted to growing corn. The ultimate impacts on species and habitat of ethanol consumption that can be attributed to the Set 2 Rule is very likely to be even smaller than these estimates imply, and there is reason to believe that they could be zero, as discussed below.

If the RFS program were hypothetically to cease to exist, it is unlikely that ethanol production would decrease by the same amount as the reduction in domestic ethanol consumption. As discussed in Section VI.B.2, domestic ethanol producers could be expected to seek to increase exports to offset the loss of domestic sales. While domestic sales may be more profitable than exports, exports would nevertheless be expected to be profitable to some extent given the already high level of exports. Between 2022–2024 ethanol exports ranged from 8 to 12% of total ethanol production. This incentive alone has the potential to result in no change in domestic ethanol production even if domestic ethanol consumption could decrease by up to 6% if the RFS program were to cease to exist.

If there were a decrease in domestic ethanol production in the absence of the RFS program, we could see decrease, although likely smaller, in total corn production. Mitigation of the decrease in corn production in the face of weakening domestic ethanol demand could occur in two ways. First, farmers may seek to increase exports of corn to offset the loss of a portion of their ethanol market. As with ethanol, while domestic sales of corn may be more profitable, exports would nevertheless be expected to be profitable to some extent given the already high level of corn exports. Second, the corn that would otherwise have been used for ethanol might be diverted to the domestic food and feed markets where it can be offered at a price that is competitive with near substitutes.

Figure VI.C.5-3: Corn Consumed Domestically for Non-Ethanol Purposes



Source: USDA's Economic Research Service.

Such a shift between the use of corn for food and feed and the use of corn for ethanol appears to have occurred between 2007 and 2012, as shown in Figure VI.A.1-1, and thus could occur again in the future. While we have not quantified the potential impacts of these two factors, it seems likely that together they would reduce the impact of ceasing the RFS program on acres devoted to corn production, already less than 1%, to significantly lower levels. Combined with the likelihood that ethanol production may not change much in response to the cessation of the RFS program, if at all, the impact on corn production may effectively be zero.

Soybean

As with the impact of the RFS Set 2 Rule on corn production and acreage, there are also many uncertainties associated with the impact of this rule on soybean production and acreage. These uncertainties are present in nearly every step of the causal chain between the increase in demand for soybean oil caused by the volume requirements in the Set 2 Final Rule to the potential increases in soybean planting by individual farmers. Some of the key uncertainties include the impact of the RFS volume requirements on domestic (vs. imported) biodiesel demand, the impact of the RFS volume requirements on demand for soybean oil (vs. other biodiesel feedstocks), the impact of increased soybean oil demand on soybean production, and the location of potential increases in soybean planting (on existing cropland vs. non-cropland). Each of these uncertainties is discussed briefly in this section.

As discussed in Section III, the primary mechanism by which the Set 2 Rule could impact listed species is through increased demand for biofuels, which could ultimately result in an increase in the cultivation of crops used as biofuel feedstocks in the U.S. The RFS program, however, does not require that the biofuels used to meet the standards be produced in the U.S. nor that they be preproduced from any particular feedstock.[24] Throughout the history of the RFS program imported biofuels have been supplied to U.S. markets to help satisfy the increased demand for biofuels attributable to the RFS program. The role that increased biodiesel and renewable diesel have played in the overall supply of these fuels to the U.S. can be seen in Figure VI.A.2-1. Similarly, as shown in Table VI.A.2-1, the makeup of the feedstocks used to produce biodiesel supplied to the U.S. has varied over time.

In this BE we have projected how much of the projected increase in the demand for biodiesel that results from the Set 2 Rule will be supplied by domestic biodiesel produced from soybean oil relative to other potential supplies of biodiesel. There are significant uncertainties associated with these projections, as the actual make up of biodiesel supplied to the U.S. (domestic vs. imports, produced from soybean oil vs. other feedstocks) will be impacted by many different factors beyond the scope of the RFS program. These factors include the availability and price of feedstocks used to produce biodiesel, demand for these feedstocks in other sectors, tariffs and trade barriers, and many others.

Another source of uncertainty in our analysis is the impact that increased demand for soybean oil for biofuel production has on soybean production and planting. To produce soybean oil the soybeans must be crushed at an oilseed crushing facility. The crushing of soybeans produced two primary products, soybean oil and soybean meal. Only soybean oil is used for biofuel production, while the soybean meal is primarily used as livestock feed. While we expect that the biofuel volume requirements in the Set 2 Rule will increase demand for soybean oil to some degree, there is much more uncertainty as to the effect any increase in demand for soybean oil will have on demand for soybeans. This is due to the fact that oilseed crushing facilities in the U.S. are currently operating at or near their crushing capacity. Crushing more soybeans to increase soybean oil production (which would in turn increase demand for soybeans) would generally require an increase in oilseed crushing capacity. Because it generally takes two years or more to build a soybean crushing facility, there is little to no ability for the Set 2 rule to increase the domestic soybean crushing capacity in 2026 and 2027 beyond the increases projected from crushing facilities currently under construction. Instead, increases in the use of soybean oil for biofuel production beyond that which can be supplied by increases in soybean oil production are likely to be sourced from soybean oil diverted from other end uses, such as food production. Increasing the use of soybean oil for biofuel production by diverting soybean oil from other markets is not expected to have an appreciable impact on soybean production and planting through 2027.

[24] Biofuels must be produced from approved feedstocks to be eligible to generate RINs (credits) in the RFS program, however multiple different feedstocks have been approved for BBD production.

In situations where an increase in demand for soybean oil for biofuel production does lead to an increase in demand for soybeans, whether through an increase of soybean crushing at existing facilities, the expansion of existing crushing facilities, or the construction of new soybean crushing facilities, there remains uncertainty as to whether this increase in soybean demand will lead to an increase in soybean production and planting. Soybean production in the U.S. is currently much greater than existing soybean crush capacity. Because of this, nearly have of the soybeans produced in the U.S. are exported to other countries. Since domestic production of soybeans is significantly higher than current demand for soybeans from domestic crushing facilities it is possible that an increase in demand from soybean crushing facilities could be met by redirecting soybeans that would otherwise be exported. In this way relatively large increases in domestic soybean crushing, and the domestic production of soybean oil, could be realized with no increase in domestic soybean production.

Finally, in situations where increased demand for soybean oil for biofuel production does result in an increased soybean planting an important factor that must be considered when estimating changes in soybean planting attributable to increased demand for soybean oil for biofuel production is the degree to which new soybean acres are planted on land that is not currently being used to produce crops or land that is currently being used to produce non-soybean crops . If new soybean acres are grown on land not currently being used to produce crops, we would expect total cropland in the U.S. to increase proportionally to the increase in soybean acres. That is, total U.S. cropland would be expected to increase by one acre for every new acre of soybeans that are planted on land that is not currently being used to produce crops. If, however, new soybean acres are planted on land currently being used to produce other crops, the situation is more complicated. In this case it is possible that the crops displaced by new soybean acres would instead be grown on land that is not currently being used to produce crops and total U.S. cropland would be expected to increase. Alternatively, it is possible that total production of the crops displaced by soybeans decreases, resulting in no increase in U.S. cropland.

Canola

Uncertainties exist for our estimated impacts on canola biodiesel production as well. EPA has not performed a new analysis to project the potential future direct effects of canola oil biodiesel consumption for this Set 2 Rule BE, though an estimate of the indirect effects of the Set 2 Rule on canola is included in the new crop price index and modeling analysis detailed above. We describe above the analysis EPA undertook to estimate total canola effects in the Set 1 BE, which was limited to North Dakota. Finally, as previously mentioned, the original analysis performed for canola and used in the Set 1 Rule BE was not based on the new volumes for the 2026–2027 time period of the Set 2 Rule. However, the new canola analyses, including the crop price index calculation for total estimated cropland impacts, that are included are adjusted for the new canola volumes in the Set 2 Rule, and the broad drivers on other markets and crops are relevant across different time frames and analyses. However, the application of analyses conducted across different time frames does create some inconsistency and potential uncertainty. Other factors external to the RFS, such as international trade policy, may also affect canola consumption in the U.S. but were considered outside the scope of this analysis. These external factors introduce additional uncertainty for our estimates.

VII. Land Use Change Potential Impacts on Listed Species

A. Identifying Potential Locations of Acres Impacted (FWS Species)

Given the acreage of new cropland estimated in Tables VI.C.4-1 and 2 potentially attributable to the Set 2 Rule, we next needed to identify the areas where those land conversion changes may occur in order to assess the potential impact on listed species and habitat (Step 2 of the process outlined in Figure ES-1). The estimates of cropland increase are higher for GLOBIOM (3.698 million acres, Table VI.C.4-2) compared with GCAM (3.354 million acres, Table VI.C.4-1). To be conservative, we use the higher estimates from GLOBIOM in the subsequent analyses in this section on potential impacts to species. There is no modeling tool that we are aware of at this time that can predict with any certainty the precise location of these land use changes.

Though we were not able to estimate the precise location of land conversions due to biofuel production that may be attributable to the Set 2 Rule, we have used a probabilistic approach to estimate the potential overlap between cropland changes and critical habitats or listed species ranges. In essence, a probabilistic approach randomly selects lands for conversion from a defined set of available land that add up to 3.764 million acres, which can subsequently be used to assess whether the species in those habitats or the habitats themselves could potentially be affected by those land conversions. If we repeat that random land-selection process many times, we generate an estimated probability of impact for the land use change estimates potentially attributable to the Set 2. This overlap could indicate a modification to the geographical area that represents the species' critical habitat and, as such, could impact essential PBFs present in critical habitat. Additionally, given the uncertainty described below, such an overlap does not indicate that such a result is likely to occur. This is the only means we have identified that could link the potential land converted and the potential overlap with species and habitats.

As shown Table VI.C.4-2, we estimate that 3.698 million acres of noncropland may be converted to cropland between 2026 and 2027. The numbers from 2026 and 2027 are not additive since new lands converted to cropland in 2026 may be re-cultivated in 2027 and indeed it is more economical for farmers to do so than to convert new lands to cropland. Thus, the highest number in Tables VI.C.4-1 and 2 is appropriate for our use and is conservative. Assuming the same trends found in Lark et al. 2015, most of this noncropland that is converted would likely be grassland, including both native and planted grasslands, as well as lands that may have been previously used for pasture or hay or retired croplands planted to permanent vegetative cover through the Conservation Reserve Program. The conversions of such lands may involve new tillage and application of fertilizers and pesticides for the new crop. This may occur inside species' critical habitat and/or range, the former which may be detrimental to the species if PBFs within the critical habitat are affected, or it may be outside the critical habitat and/or range.

Conversion outside the critical habitat and/or range may also affect the species through things such as pesticide drift or overland flow of nutrients or pesticides. A common buffer used to capture potential effects to nearby habitat is 2600 feet.[25] The effect of the conversion of one crop to another (e.g., wheat to corn, soy to corn), depends on the specific conversion considered, and the species under consideration (because some species may be more sensitive to the pesticides for one crop over another). Corn uses more fertilizers than most other crops, but soybean uses less nitrogen fertilizer and is responsible for the bulk of the cropland expansion (Table VI.C.4-2); and the mixture of pesticides used may differ from crop to crop, with differing effects depending on the crop switch and species under consideration. For example, the rise of genetically engineered corn and soy facilitated greater adoption of glyphosate-based pesticides, which are less toxic to many non-plant species than many of the pesticides used earlier. Because of these complexities, and because we anticipate the largest potential effect on species to be from conversion of non-cropland habitat to any cropland, we focus on the increase in total cropland of 3.764 million acres (rather than the increase in a specific crop planting) as the effect to examine in terms of the impacts of land use change on listed species. Impacts on species from water quality impacts are discussed in Section VIII.

To assess the potential land use impacts on listed species from increased demand for biofuels using a probabilistic approach, we began with the area of potential land use change in Figure IV.B.4-1, which includes most of the Midwest, East, and agricultural areas in the West. We then overlayed that with the critical habitat and the range data provided by the Services. We first discuss results for FWS species and then NMFS species separately.

Not all land in the area of potential land use change is likely to be converted to agriculture (e.g., urban areas, water, etc.). We used land cover classes from the National Land Cover Dataset (NLCD) at the 30-meter resolution to identify areas for potential conversion from non-cropland to cropland. Lark et al. (2015) found that the most common land cover type converted to crop production was grassland (77%), shrubland (8%), and idle land (8%). We used as the summation of four land cover classes and the most likely set of land for potential conversion the following:

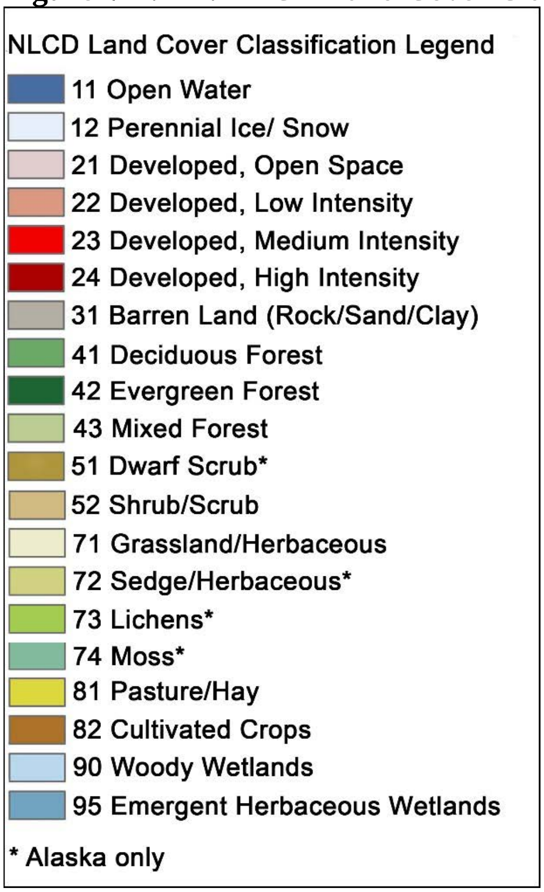
- shrub (NLCD class #52)
- grassland/herbaceous (#71)
- pasture/hay (#81)
- emergent herbaceous wetlands (#95)

Idle land is not a land cover class in the NLCD and is likely pasture/hay. Wetlands have a high conservation value for the ecosystem services that they provide and as habitat for many species, and emergent herbaceous wetlands are easier to convert to agriculture than wooded wetlands due to the absence of trees. Thus, to be conservative we included this land cover class. Other land cover classes are unlikely to be converted to cropland in the area of potential land use change. Forested areas are uncommon, more difficult to convert to agricultural production, and were found in Lark et al. (2015) to account for a small percentage (3%) of lands converted to

[25] From the EPA Revised Method for National Level Listed Species Biological Evaluations of Conventional Pesticides (US EPA, 2020): "The endpoint that results in the farthest distance from the treated field where any effect to the listed species or it's Prey, Pollination, Habitat, and/or Dispersal (PPHD) may occur relative to a specific listed species will be used to determine the off-site transport distance for that species. This distance is capped at 2600 feet (the area limit of the AgDRIFT model)."

agriculture. We therefore focus on the total of these four land cover classes as the source of land for potential conversion to cropland. Thus, the initial set of lands potentially available for conversion were all areas within the action area that were comprised of NLCD classes 52, 71, 81, and 95.

Figure VII.A-1: NLCD Land Cover Classes for Potential Conversion



In order to determine how the 3.698 million acres of conversion were to be distributed, we considered the factors used to estimate the national-level acreage impacts shown in Table VI.C.4-2. These effects manifest either through biofuel production or through price effects. Effects through production are simulated to occur closer to biorefineries (i.e., within 25 miles for corn in Li et al (2019), within 50 miles for soybean in Miao et al. 2025), while effects through price may occur anywhere in the action area. We simulated the conversion of 3.764 million acres of available non-cropland to cropland randomly across the area of potential land use change.

We compared the location of 3.698 million acres of land conversion with critical habitat potentially affected species. To do this, we first removed any isolated patches of available land less than 15 acres in size. This is based on the notion that isolated small areas are unlikely to be converted to farms and are more likely misclassified 30 m pixels in the NLCD. We then overlayed a grid over the continental United States (CONUS) and randomly sampled 3.698 million acres of available land in the area of potential land use change for conversion. We employed a 3-acre grid for sampling, with the exception of the analysis for the FWS range species, where we used a 15-acre grid, given the computational requirements imposed by the greater number of species and the large range areas for many species. We then randomly selected grid cells for conversion until the 3.698 million acres was reached. We then compared this area with critical habitat to estimate the area of critical habitat estimated to be converted to cropland for each species. We repeated the 3.698 million acre-conversion simulations 500 times to generate a distribution of probabilistic effects (except for the FWS range where we used 100 simulations).

We also ran simulations for conversion of 3.698 million acres that included a 2600-foot buffer around critical habitat to account for pesticide drift or other potential effects nearby to species' critical habitat. For simulations with the buffer added, we deliberated on how to calculate the percent of species critical habitat or range impacted, whether to divide the converted acreage by the total area considered (e.g., critical habitat and buffer) or only by the critical habitat or range area for that species. We found that in simulations with the buffer included, the total area affected for a species often increased due to the inclusion of the buffer, but the percent of area affected decreased. This occurs because the addition of buffer in the percent calculation (denominator) adds a large amount of non-critical habitat area. We calculated the percent area affected both ways to capture the full range of possible ways to express potential impacts, namely: (a) ((area of critical habitat + buffer impacted) / total area of critical habitat + buffer)*100, and (b) ((area of critical habitat+ buffer impacted)/ (total area of critical habitat))*100. For this reason, each scenario with a buffer includes two different calculations, labeled a and b, denoting whether or not the buffer was included in the denominator for percent calculations (Table VII.A-1). Both approaches are reasonable but capture slightly different approaches to estimating impact. The percent using approach (a) may be interpreted as meaning the percent area in and around critical habitat affected by conversion in and around critical habitat. The percent using approach (b) may be interpreted as meaning the percent area *of critical habitat* affected by conversion in and around critical habitat.

Finally, conversion to cropland may impact a species even if it is well outside the critical habitat if it is within the range that the species occupies. We repeated the above analyses using the range of species instead of the critical habitat. Because the ranges of species are much larger than the critical habitat, the simulations were much more computationally intensive. Thus, we reduced the number of replicates for the range simulations to 100 and, as noted above, we used a 15-acre grid, rather than a 3-acre grid. In total, there were four scenarios run to assess effects on species critical habitat and range (Table VII.A-1), each run either 500 or 100 times. The results are summarized separately by critical habitat (CH) and range, and by the absence or presence of a buffer.

Table VII.A-1: List of Scenarios for FWS Species-Level Effects From Increases in Cropland

Scenario #	Total Acres Converted (million acres)	Critical Habitat (CH) or Range (R)	Buffer	Grid Size (acres)	Replicate Iterations	Buffer included in denominator for % calculations
S1	3.764	CH	None	3	500	N/A
S2a	3.764	CH	2600’	3	500	Y
S2b	3.764	CH	2600’	3	500	N
S3	3.764	R	None	15	100	N/A
S4a	3.764	R	2600’	15	100	Y
S4b	3.764	R	2600’	15	100	N

For each species, we calculated the average critical habitat or range estimated to be converted across all simulations, expressed in total acres converted and percent of critical habitat or range converted. If the average percent of critical habitat estimated to be converted exceeded 1%, that species was flagged for additional scrutiny. That said, all species results, regardless of if they exceeded this threshold, were retained for the record (Attachment 1). A few of the species, particularly marine species (e.g., sea turtles), had habitat or range extending beyond the conterminous U.S. In those cases, we estimated the habitat or range converted as a percentage of habitat or range within the conterminous U.S. and also as percentage of the total habitat or range globally. Further, it is important to note that several marine, coastal, or anadromous species are under both FWS and NMFS jurisdiction. As identified in Section V, they include 8 species: the Gulf Sturgeon (Atlantic Sturgeon Gulf subspecies), Loggerhead Sea Turtle, Green Sea Turtle, Leatherback Sea Turtle, Hawksbill Sea Turtle, Kemp’s Ridley Sea Turtle, Olive Ridley Sea Turtle, and Atlantic Salmon. In these cases, FWS jurisdiction may apply when the species is on land, whereas NMFS jurisdiction may apply while they are in the water. For this reason, these species or populations were assessed in both the FWS analyses (results in Section VII.B immediately below) and again in the NMFS analyses (results in Section VII.D). For each species or population in each analysis, EPA used the corresponding GIS range shapefile and, where applicable, critical habitat shapefile, that were provided by each Service.

B. Potential Impacts on Listed Species and Critical Habitat (FWS species)

For the analysis of critical habitat with no buffer (S1), we found that roughly 205 unique species were impacted at least once across all simulations (Table VII.B-1). In addition to the frequency of impact across simulations, though, the magnitude of those impacts is also relevant. We also tabulated the amount and percent of critical habitat impacted by species. We found that 16 species had one percent or more on average of their critical habitat impacted (i.e., conversion within critical habitat), including five fish, five insects, four plants, and one species each of crustacean, mollusk, and mammal. Because we used the average, there were some individual simulations where the percent of critical habitat converted could exceed 1%.

For the analysis of critical habitat with a 2600’ buffer (both S2a,b), we found that 220 unique species were impacted at least once across all simulations (Table VII.B-1). For S2a and

S2b, with- and without the buffer in the denominator (see section VII.A), we found that 7 and 122 species, respectively, had 1% or more of its critical habitat plus buffer potentially impacted (i.e., conversion within critical habitat or within 2600’ of critical habitat). This included zero (for S2a) or five species (for S2b) with more than 10% of the critical habitat potentially affected.

For the analysis of species range with no buffer (S3), we found that 1,041 unique species were impacted at least once across all simulations (Table VII.B-1). Because nearly the entire CONUS is covered by the range of at least one listed species, it is expected that much of the projected land conversion would occur in the range of at least one listed species. Despite these estimated conversions of range, we found only 13 species had one percent or more of its range converted (Table VII.B-1).

For the analysis of species range with a 2600’ buffer (S4a,b), we found that 1,052 unique species were impacted at least once across all simulations. We found 10 and 37 species had one percent or more of its range converted, respectively for S4a and S4b (Table VII.B-1).

The species most affected as assessed by percent of critical habitat or range potentially converted are shown in Table VII.B-1 (full results of all species are included as an excel sheet attached to this BE). We provide more information on the potentially impacted species further below, including information on some of the species that have the largest potential impacts based on these acreage impact results alone (and not on other important information including PBFs for critical habitat). Additional discussion and our determinations for FWS species can be found in Section IX.B, where we also consider impacts to PBFs in more detail.

Table VII.B-1: Summary of Effects Across Scenarios From the Probabilistic Analysis (FWS Species)

Scenario #	# Spp. impacted at least once	Number of spp. with 1% or more of CH or range impacted on average	Common name of sp. with >1% of CH or range converted (% affected)*
S1	205	16	Umtanum desert buckwheat (1.5%), White Bluffs bladderpod (1.4%), Clay-Loving wild buckwheat (1.4%), Dakota Skipper (1.4%), Delta green ground beetle (1.4%), Chucky Madtom (1.3%), Poweshiek skipperling (1.3%), Salt Creek Tiger beetle (1.2%), Fresno kangaroo rat (1.2%), Topeka shiner (1.2%), Fleshy-fruit gladecress (1.2%), Brawleys Fork crayfish (1.2%), Amber darter (1.1%), Slackwater darter (1.1%), False spike (1.1%), Niangua darter (1.0%)
S2a	220	7	Delta green ground beetle (1.4%), Umtanum desert buckwheat (1.4%), Clay-Loving wild buckwheat (1.4%), White Bluffs bladderpod (1.2%), Dakota Skipper (1.1%), False spike (1.1%), Slenderclaw crayfish (1.1%)
S2b	220	122	Fleshy-fruit gladecress (37.2%), Navasota False Foxglove (29.4%), Alabama cavefish (20%), Clay-Loving wild buckwheat (14.8%), Slenderclaw crayfish (10.8%), Devils River minnow (9.8%), Chucky Madtom (9.6%), Noel's Amphipod (9.0%), Slackwater darter (8.9%), false spike (8.8%), Niangua darter (7.8%), Umtanum desert buckwheat (6.7%), Roswell springsnail (6.7%), Barrens topminnow (6.7%), Koster’s springsnail (6.6%), Amber darter (6.5%), Braun’s rock-cress (6%), Short’s bladderpod (6%), Brawleys Fork crayfish (6%), Guadalupe Orb (5.5%)
S3	1041	11	Virginia round-leaf birch (1.6%), Umtanum desert buckwheat (1.5%), Bliss Rapids snail (1.2%), Slenderclaw crayfish (1.2%), Clay-Loving wild buckwheat (1.1%), Neosho madtom (1.1%), Chucky Madtom (1.1%), Pariette cactus (1.1%), Madison Cave isopod (1.0%), Howell"s spectacular thelypody (1.0%), Neosho Mucket (1.0%)
S4a	1041	8	Umtanum desert buckwheat (1.3%), Virginia round-leaf birch (1.2%), Slenderclaw crayfish (1.2%), Neosho madtom (1.1%), Bliss

			Rapids snail (1.1%), Chucky Madtom (1.1%), Pariette cactus (1.0%), Clay-Loving wild buckwheat (1.0%)
S4b	1052	34	Virginia round-leaf birch (9.6%), Umtanum desert buckwheat (2.8%), Iowa Pleistocene snail (2.7%), Bliss Rapids snail (2.2%), White Bluffs bladderpod (1.6%), Clay-Loving wild buckwheat (1.5%), Slenderclaw crayfish (1.4%), Chucky Madtom (1.4%), Snake River physa snail (1.4%), Jesup's milk-vetch (1.3%), James spinymussel (1.3%), Pariette cactus (1.3%), Chittenango ovate amber snail (1.2%), Grotto Sculpin (1.2%), Virginia fringed mountain snail (1.2%), Fleshy-fruit gladecress (1.2%), Western regal fritillary (1.2%), Neosho madtom (1.2%), Howell's spectacular thelypody (1.1%), Madison Cave isopod (1.1%)

* For entries with more than 20 species only the top 20 are listed.

Plants

Based on our analysis, the Fleshy-fruit gladecress could be impacted by pesticide drift from cropland expansion due to increases in cropland from the RFS Set 2 Rule. The S2b scenario suggests that, on average, 37.2% of the area representing this species' critical habitat could be affected by activities in the critical habitat and the surrounding buffer. Found only in the state of Alabama, this endangered species has been primarily affected by habitat destruction with off-road vehicle use and agricultural conversion as threats to their growth. They tend to thrive in limestone outcroppings near forest edges as shade plants will inhibit their growth. The existing populations reside primarily on residential lands and in rocky outcrops in pasture fields (US FWS, n.d.-d). While the Fleshy-fruit gladecress' critical habitat may be affected when considering the impacts of activities in the surrounding buffer, our analyses show that less than 1% of the critical habitat plus buffer may be converted and only 1.2% of its critical habitat itself may be converted, according to S2a and S1, respectively. Further, only a small percentage of its range plus buffer (S4a; 0.81%) and range by itself (S4b; 0.08%) may be converted.

The Clay-loving buckwheat is primarily affected by recreational vehicle traffic and livestock grazing. It is also impacted by other stressors including commercial and residential development, invasive species, and environmental change. This endangered species is predominantly located in Colorado and the land they thrive on is described as barren and inhospitable to most vegetation. Because of this specific terrain, this plant has limited habitat and is highly fragmented. Currently there are numerous conservation efforts in place to mitigate stressors and enhance habitat conditions (US FWS, 2022). Approximately, 14.8% of its critical habitat could be affected by conversion in the buffer (S2b), while only 0.4 and 0.1% of this species' critical habitat (S1) and range (S3), respectively, could be converted to agriculture based on our analysis. This could potentially contribute to more livestock grazing. However, it is unknown if any potential agricultural production would actually occur in many of these locations, since the lands where these species are found are barren with clay-rich soils which may present challenges for farming.

Aquatic Species

Many of the FWS species in Tables VII.B-1 are aquatic species. Although the probabilistic analysis we conducted was a land use change exercise, it is possible that these species were picked up if their critical habitat or range includes riparian or other surrounding lands. If land use changes were to occur in such locations, they could still impact the species by pesticide drift (demonstrated with S2b and S4b) or localized water quality impacts. However, it is possible that land use changes may not impact the aquatic species at all if, for instance, a farmer uses best management conservation practices on the new cropland, or if the unique geomorphology of the land directs runoff to another location where the species is not present. At this time, we are unable to assess these factors fully.

Based on our results, one aquatic species that may be impacted is the Slenderclaw crayfish. Located in Alabama, this endangered species' critical habitat could be impacted by pesticide drift based on S2b. A very small percentage of its critical habitat (S1; 0.03%) and range (S3; 0.1%) could be impacted directly. Historically, the largest impact to their critical habitat occurred with the construction of the dam for the Tennessee River. This dam created Lake Guntersville in 1939 which destroyed several habitats and isolated the two remaining populations from each other. The remaining two habitats have also experienced impacts from invasive species and water pollution, including pollution from upstream animal farming (US FWS, 2019).

The Noel's amphipod is another type of crustacean. Their habitat, located in New Mexico, has similarly been historically affected by water quality impacts. Their population is thought to exist only in the Bitter Lake National Wildlife Refuge. Because this endangered species is located entirely in a wildlife refuge, impacts from nearby land changes have been greatly reduced (US FWS, n.d.-f). Any land converted to corn cropland would likely be located a significant distance from their habitat.

Based on our analysis, the Devils river minnow may be impacted by pesticide drift from newly converted lands. None of its critical habitat, and only a small percentage of its range, however, could be directly impacted. This threatened fish is found in a small area of the Del Rio in southern Texas. Its range was at some point considerably larger but has shrunk due to pollutants entering the local aquifer and drought which impacts their reproductive grounds.

Darters are small freshwater fish which tend to live along the bottom of rivers. Because of this bottom dwelling tendency, they are more susceptible to impacts on water quality than other species. They use the rocky or sandy bottom of waterways for protection and foraging. Any addition of silt due to soil erosion could impact their habitats. The Amber darter for example lives in two rivers in Georgia and Tennessee. This endangered species has been affected by water quality impacts including land change, urbanization, and extreme weather events associated with environmental changes. These weather events cause changes in the flow of the rivers potentially disrupting their reproductive habitats. Recovery plans are in place. However, construction of a reservoir near one of their habitats has the potential to disrupt waterflow and further alter their existing habitat (US FWS, n.d.-a). The Amber Darter could see very small direct impacts to its critical habitat and range, based on our analyses.

Freshwater mussels are an important species in all ecosystems. They are filter feeders that siphon their food from the water, eating mostly small organisms and organic materials. Similar to the discussion of darters above, freshwater mussels live along the bottom of waterways. This makes them susceptible to the impacts of poor water quality and pollution. The False spike, Guadalupe orb, and Texas Pimpleback are all endangered freshwater mussel species with critical habitat found mostly in Texas. Habitat change for these mussels has been attributed to water flow inconsistency, with rivers being prone to both flood and drought. Inconsistent water flow can change the terrain on the river bottom where they tend to dwell in the gravel and cracks of rocks. The rivers also flow through areas of high agriculture and pastoral lands which both pump water from the habitats and contribute to water pollution. Recent conservation efforts have increased their focus on freshwater mussel populations. Recovery efforts with the Texas pimpleback for example, have been working to breed and redistribute these mussels into the waterways (Buzek 2021).

C. Identifying Potential Locations of Acres Impacted (NMFS Species)

We used the same general procedures for identifying potential locations of cropland expansion for NMFS species as with FWS species. As for the FWS species, scenarios with a buffer included two different calculations, labeled a and b, denoting whether or not the buffer was included in the denominator for percent calculations (see Section VII.A and Table VII.A-1 for more details). We ran 500 replicates across all scenarios.

D. Potential Impacts on Listed Species and Critical Habitat (NMFS Species)

Because NMFS species include marine species, with potentially large aquatic critical habitat or range areas that cannot be converted to cropland, these are potentially only affected if cropland expansion is near the coast or if species migrate between inland waterways and the marine environment, such as anadromous species of salmon and steelhead. In these cases, effects in the buffer surrounding the critical habitat have the potential to have runoff effects. Because of this, only scenario 2b—with a 2600' buffer around critical habitat—resulted in any species with 1% or more of area affected in the probabilistic analysis (Table VII.D-1). As noted in previous sections, percentages in scenario 2b are calculated by taking the area potentially impacted in the buffer and critical habitat (or range) and dividing it by only the area in the critical habitat (or range). This is in contrast, to scenario 2a, that includes the area of the buffer in the denominator Thus, scenario 2b is a more conservative estimate of potential effects (see section VII.A for more details on scenario calculations). The potentially impacted species under scenario 2b include the Chinook salmon, Eulachon, Atlantic sturgeon, among others. We include additional background information on these species, as well as other NMFS fish species directly below. Additional discussion is included in Section IX.C. For cumulative effects from runoff to downstream aquatic habitats, see Section VIII.

Table VII.D-1: Summary of Effects Across Scenarios. DPS is Designated Po

Scenario #	# Spp. impacted at least once	Number of spp. with 1% or more of CH or range impacted on average	Common name of sp. with >1% of critical habitat or range converted (% affected).
S1	27	0	NA
S2a	27	0	NA
S2b	27	14	Salmon, Chinook [Snake River fall-run Evolutionarily Significant Unit—ESU] (3.0%); Salmon, Chinook [Upper Willamette River ESU] (2.3%); Salmon, Sockeye [Snake River ESU] (1.9%); Salmon, Chinook [Upper Columbia River spring-run ESU] (1.6%); Salmon, Chum [Columbia River ESU] (1.0%);

			Steelhead [Upper Willamette River Distinct Population Segment—DPS] (3.1%); Steelhead [Upper Columbia River DPS] (2.5%); Steelhead [Puget Sound DPS] (1.5%); Steelhead [Snake River Basin DPS] (1.4%); Eulachon (1.4%); Sturgeon, Atlantic (Atlantic subspecies)[South Atlantic DPS] (1.4%); Sturgeon, Atlantic (Atlantic subspecies)[Chesapeake Bay DPS] (1.2%); Sturgeon, Atlantic (Atlantic subspecies)[Gulf of Maine DPS] (1.0%); Sturgeon, Atlantic (Gulf subspecies) (1.0%)
S3	31	0	NA
S4a	31	0	NA
S4b	31	0	NA

Salmonids are anadromous fish, hatching in inland rivers and streams, eventually migrating to saltwater to feed and grow, and then returning to fresh water to spawn. Of the salmonids, our probabilistic analysis suggests the critical habitat of the Chinook salmon [Snake River fall-run ESU] may be most affected through impacts in the buffer under scenario 2b (3.0%), with no effects exceeding the 1% threshold in other scenarios. The Chinook salmon is the largest of the Pacific salmon, with its range extending from Monterey Bay in California to the Chukchi Sea in Alaska (NOAA Fisheries, 2025d). They hatch and live in the juvenile stage in fresh water before migrating to the ocean. Typically, they return to their native streams after three or four years to spawn, either in the summer or fall (NOAA Fisheries 2026a).

The Sockeye salmon is another salmonid species found along the west coast of North America, ranging from the Klamath River in Oregon to Point Hope in northwestern Alaska. The largest Sockeye salmon populations are found in Kvichak, Naknek, Ugashik, Egegik, and Nushagak Rivers that flow in Alaska's Bristol Bray, as well as the Fraser River system in Canada. Our analysis suggests the critical habitat of the Sockeye salmon [Snake River ESU] may be affected through impacts in the buffer under scenario 2b (1.9%). Sockeye salmon are particularly vulnerable to habitat and migratory disruptions from blocked access to spawning grounds caused by dams and culverts (NOAA Fisheries, 2025i). The Chinook salmon [Upper Willamette River Evolutionarily Significant Unit (ESU)] and Chum salmon [Columbia River ESU] are the other populations with the potential to be affected by activity in the buffer around critical habitat, with all affected populations located in the Pacific Northwest region.

Like salmon, steelhead are anadromous fish, migrating between inland and marine waters. Our analysis suggests steelhead critical habitat may be affected through impacts on the buffer under scenario 2b, with effects exceeding 1% for select populations, such as the Upper Willamette River Distinct Population Segment (DPS) (3.1%). Steelhead are rainbow trout requiring fast flowing, oxygenated rivers and streams to hatch. They subsequently migrate to the ocean, generally growing larger than their strictly fresh water counterparts (NOAA Fisheries, 2025j). Unlike salmon, steelhead may return to fresh water habitat to spawn multiple times throughout their lifecycle, returning to the marine environment in between spawning. Barriers, such as dams, represent a major stressor to steelhead, by disrupting migration and reducing flows (Robards and Quinn, 2002). Like salmon, all potentially impacted populations are in the Pacific Northwest region (the Upper Columbia River DPS; Puget Sound DPS; and Snake River Basin DPS, in addition to the Upper Willamette DPS).

Eulachon are anadromous smelt species found along the Pacific Coast, from northern California to southwest Alaska (NOAA Fisheries, 2025m). The southern DPS of the Eulachon is currently threatened and is found from northern California to British Columbia, Canada. The probabilistic analysis suggests the southern DPS of the Eulachon may be affected through impacts on the buffer under scenario 2b (1.4%), with no effects exceeding the 1% threshold in other scenarios. Eulachon hatch in coastal rivers, with juvenile fish moving to marine waters within the first year. They typically return to coastal rivers to spawn between the ages of 2 and 5 years old. Changes to ocean conditions, dams and water diversions, and bycatch are considered the highest threats to the southern DPS of the Eulachon (NMFS, 2017).

Finally, sturgeon are one of the most endangered species in the United States. There are currently 29 species, most live in the ocean and travel upriver during the spring and summer to spawn. In the probabilistic analysis, the Gulf sturgeon (a sub-species of the Atlantic sturgeon) and three populations of the Atlantic sturgeon were identified as having 1% or greater of critical habitat impacted, as shown in scenario S2b above. The Gulf sturgeon, as the name suggests, resides primarily in the Gulf region of Louisiana, Mississippi, and Florida. Populations of Gulf sturgeon have been impacted over the years from factors such a dam construction to water degradation. As sturgeon spawn in the rivers during the summer, dams can impede their cycle and have been known in some cases to separate some species above and below the obstacle. The remainder of the year, they live in estuarine waters, mixed salt and fresh water areas, and fully in the ocean during the winter months. Pollutants pose a significant effect to the Gulf sturgeon. Impacts may be caused directly by impacting their organs and reproductive systems or indirectly by becoming incorporated into the food they eat (NOAA Fisheries, 2025f; US FWS, n.d.-b). Like the Gulf sturgeon, the Atlantic sturgeon is also anadromous, using both inland and coastal, marine waters. Atlantic sturgeon are large, slow growing fish, ranging from Florida to Canada (NOAA Fisheries, 2025l). From north to south, scenario 2b identified the critical habitat of the South Atlantic DPS, the Chesapeake Bay DPS, and the Gulf of Maine DPS of the Atlantic sturgeon as potentially impacted above 1% through buffer effects. No other scenario found an impact above this threshold.

VIII. Potential Impacts on Listed Species from Changes in Water Quality

In addition to contributing to agricultural intensification or the conversion of non-cropland to cropland within species' critical habitat and ranges, increased demand for biofuels can also negatively impact water quality. These water quality impacts are related to the land use changes to produce biofuel crops discussed in the previous sections. Water quality can be adversely impacted by the production of biofuel feedstocks, primarily due to the sediment, nutrients, and pesticides directly or indirectly released during the production of biofuel feedstocks. Increased production of crops used to produce biofuels can impact water quality at nearby edge-of-field streams and rivers as well as at a significant distance from the location of the land use change as contaminants associated with crop production travel downstream and into major waterways. This is particularly true for contaminants with greater mobility and contaminants that persist for longer time periods in soil and aquatic environments. This section begins by discussing the water quality impacts associated with crop production and then uses the best available data to project potential impacts of the Set 2 RFS volume requirements on water quality.

A. Potential Impact of Increased Crop Production on Water Quality

Increased crop production and expansion of new cropland leads to changes and increases in fertilizers and pesticides used to grow and protect these crops. Water quality assessments have often suggested that agriculture is a leading source of water quality problems. Although not intended by farmers, pollutants such as sediments, nutrients and pesticides travel from fields to sources of water such as rivers and streams (Robertson & Saad, 2019). USGS quantifies fertilizer contributions to total nitrogen (TN) and total phosphorous (TP) concentrations in water drainage basins with its SPARROW model (SPAtially Referenced Regression On Watershed attributes). USGS has also studied the effects of pesticides in water through the National Water-Quality Assessment Project (NAWQA), which has indicated that the mere existence of agricultural land alone in a watershed is a reasonable predictor for the existence of surface level water contamination of common pesticides. In a sampling study testing sites in the Mississippi River Basin, USGS found that deethylatrazine, atrazine, and metolachlor alone were present in 100% of stream samples and a majority of all groundwater samples as well (Stark et al., 2000). The pesticide concentrations are therefore highest closest to fields where their application occurs (for example, in upland tributaries).

In addition to effects from fertilizers and pesticides, impacts may occur from soil disruption such as erosion and sedimentation. Soil erosion is often increased due to tillage and cultivation of land. Additionally, if previously vegetative land such as grassland is left uncovered, this may increase the amount of erosion leading to sedimentation in nearby water systems or municipal drainage. Increases in sediment in streams and rivers can raise streambeds, which could lead to an increase in flooding. This also impacts the habitats of aquatic life, especially those that are considered bottom dwellers such as freshwater mussels.

It is important to recognize that the existing land that may be converted into cropland or used to produce more crops (e.g., through intensification of existing cropland) already affects water quality. Pasture or grazing land, for example, have effects on water quality as herbicides may be used on these lands and sediment transport could still be an issue. For example, based on California Pesticide Use Report database, in 2021 Amador County pastureland applied a variety of pesticides including glysophate as a weed control to their acreage. Like other kinds of pesticides, these chemicals are known to drift from their place of application into local bodies of water.

Unless managed correctly, pasture and rangelands may experience poor forage coverage and heavy traffic from animals. This can also cause soil erosion and sedimentation into local waterways and affect habitats of aquatic species downstream such as bottom feeding mollusks and fish such as the steelhead trout which spawns in rocky river bottoms. Additionally, urine and feces from animals on such lands can contribute to nutrient deposition in local waterways (Hubbard et al., 2004). These factors can cause potential impacts to land even before it is converted or intensified for crop production, which can contribute to uncertainty in identifying the specific sources of water quality impacts around cropland.

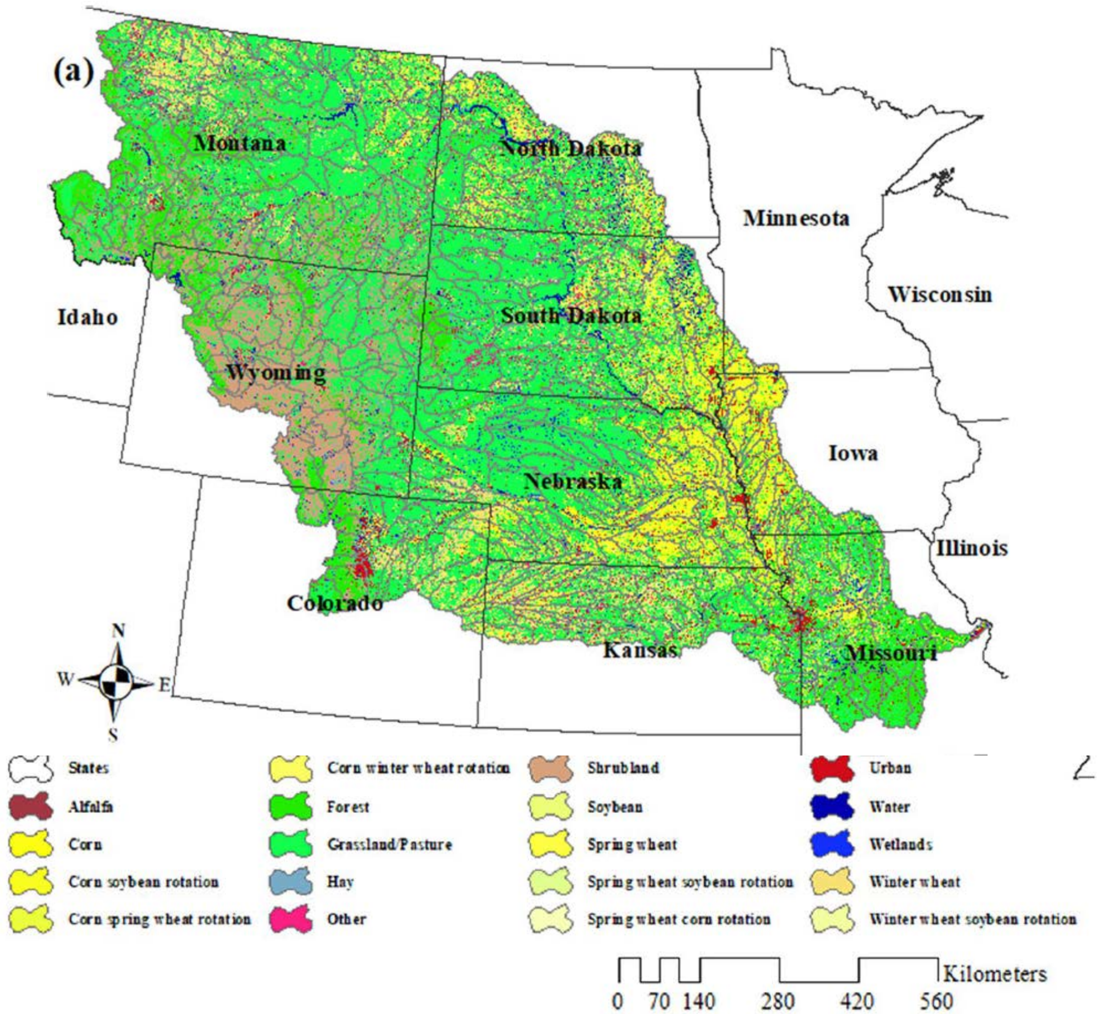
1. Estimated Potential Impacts of Increased Fertilizer Use

Estimating the impact of increasing crop production is inherently complex. The impact of crop production on water quality is impacted by a wide variety of different factors including agricultural practices, soil type, rainfall, and many others, which can vary widely depending on where biofuel crops are produced. Further, individual contaminants such as sediments, nitrogen, phosphorus, and various pesticides have differing characteristics that impact their mobility and persistence in soil and aquatic environments. To address the complexities associated with estimating changes in water quality various models have been developed, such as the Soil and Water Assessment Tool (SWAT). SWAT is a small watershed to river basin-scale model used to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use and land management practices, and environmental change. SWAT has been used in numerous peer reviewed publications to assess the water quality impacts in various regions of the United States and around the world (Wang et al., 2019). The EPA has also developed several model and water quality databases, or inventories, such as the National Nutrient Inventory.

Given the inherent uncertainty of predicting land use change as a result of the RFS Set Rules, and even further, water quality impacts as a result of that uncertain land use change, we did not have access to any one model or analysis showing water quality impacts of the Set 2 Rule. Instead, we have included two analyses of potential water quality impacts in this BE. First, we are including the SWAT modeling that was performed in support of the Third Triennial Biofuels Report to Congress (RtC3) by Chen et al., which was the primary water quality analysis used in the Set 1 BE. While this analysis is not directly tied to the Set 2 volumes or potential land use change effects, it provides a supporting framework for potential water quality impacts from biofuel volumes related to the RFS. With the resources available for this BE, the 2021 SWAT modeling is still the best available data of its kind for analyzing water quality impacts relevant to the Set 2 Rule. However, the data is increasingly further in the past for the Set 2 volumes as compared to the Set 1 volumes, and so the EPA has also performed a new historic nutrient trends analysis with the best and most recent data to supplement the SWAT modeling. This analysis is divided into three parts and attempts to capture the change in water quality, with nitrogen and phosphorous as primary proxies for overall quality, over the past two decades. This timeframe is best suited to capture the recent effects of the RFS rules since the SWAT modeling was performed, although as previously established, many other factors are likely contributing to cropland conversion and therefore the analyzed changes in water quality. Additionally, as also previously established, many other factors contribute to water quality beside cropland conversion due to biofuels and may provide obfuscating nutrient or pesticide contributions to local waterways. The pesticide and nutrient concentrations are highest close to where they're applied and then dilute from their original source as they travel downstream, where they then also combine with pollutants from other sources as tributaries merge into larger waterways. Both of the water quality analyses performed for this BE contain these uncertainties, especially the SWAT modeling.. With the general effects of cropland conversion on fertilizer loading in waterways illustrated, however, we can generally use the historical trends analysis combined with the past SWAT modeling to visualize what may occur in the future as a result of the Set 2 Rule.

One more difference between the analyses is that the SWAT modeling is generally focused on the Missouri river basin, while the historic nutrient trends analysis is nationwide. The Missouri river basin (Figure VIII.A-1) was chosen as the geographic area for this analysis because this is the region in which some of the highest rates of grassland conversion to cropland occurred from 2008–2016 when the domestic production of biofuels, particularly ethanol, expanded greatly (Lark et al., 2020). Much of the observed increase in cropland during this time period was the result of the conversion of grassland to cropland to produce corn and soybeans.

Figure VIII.A-1: Modeling Domain in Chen et al. (2021) and the Land Cover Types



While the watershed basin emphasis lent itself well to modeling more specific water quality impacts, it focused on a scope narrower than that of the rule. The historic nutrient trend analysis is focused on a national scale, to better expand on the impacts of the national volumes set in the Set Rules. Because the Set 2 Rule does not focus on individual regions but instead has the potential to affect much of the United States, as shown in Section VI, the nutrient trends analysis allows us to view watershed effects normalized across the scope of such a national rule.

a. SWAT Modeling Performed for the RtC3 and Implications for the Set 2 Rule

The SWAT modeling conducted in support of the RtC3 estimated the water quality changes associated with land use change in the Missouri river basin documented by Lark et al. from 2008 to 2016. The modeling considered three different scenarios where grassland[26] was

[26] Here "grassland" merely means land covered with grass. Lark et al. (2020) attempted to isolate lands that had been covered in grass for 25 years and assumed to be uncultivated for that entire period. There is uncertainty in how

converted to continuous corn, a corn/soybean rotation, and a corn/wheat rotation. The total quantity of land converted to cropland in the Missouri river basin during this time period was approximately 2.51 million acres. For the purposes of the SWAT modeling, all of the converted land was assumed to previously be grassland. The SWAT modeling considered the impact of this conversion to cropland on total suspended sediments, total nitrogen (including both dissolved and organic nitrogen) and total phosphorus (including both dissolved and organic phosphorus).

While the SWAT modeling conducted in support of the RtC3 does not exactly match the land use changes we projected could result from the RFS volume requirements in 2026–2027 we believe it is a reasonable proxy and that it provides the best information available on the types of water quality impacts we may see from this action. The three scenarios considered in the SWAT analysis (conversion of grassland to continuous corn, corn/soybean rotation, and corn/wheat rotation) are consistent with the types of land conversion we expect would result from increasing biofuel demand. The total area converted from non-cropland to cropland in the SWAT modeling (2.51 million acres) is also similar to the total conversion we expected from the Set 1 action, although it is substantially less than the 3.088–3.354 million acres of potential total conversion from the Set 2 action (see Table VI.C.4-1). If we apply this scaling factor of 1.33, or 33% more total cropland impacts, to the SWAT modeling results, we might be able to approximate potential water quality impacts attributable to the Set 2 volumes. However, given that the results of such a scaling effort would be a very rough approximation and does not reflect the many different factors that influence water quality impacts, which may not scale up evenly, we have retained the original results from the 2.51 million acres analysis here and have not applied the scaling factor.

We also note, however, that in the SWAT analysis all 2.51 million acres of land conversion occurred in the Missouri river basin, while the projections of conversion to cropland attributable to the RFS volume requirements could occur on any available land in the action area, which is substantially larger than the Missouri river basin.

As noted above, the model in Chen et al. (2021) was used to simulate three crop scenarios representing conversion of grassland (G): continuous corn (C), corn/soybean rotation (C/S), and corn/wheat rotation (C/W). Conversion to different types of cropland is important because there are significant differences in the average application rates of nitrogen and phosphorus between crops (See Figure VIII.A-2); for example, conversion to soybean would require less nitrogen application relative to corn, wheat, and cotton. Conversion was simulated only in locations of observed land use changes from Lark et al. (2020) and was summarized for two periods, 2008–2012 and 2008–2016. The SWAT model then estimated stream flow and riverine sediment and nutrient loads throughout HUC-8 watersheds in the Missouri River Basin (MORB). Changes observed in water quality continued to increase over the two periods, consistent with the magnitude of increased cropland conversion, as seen in Figure VIII.A-1. Historical cropland conversion from non-cropland during 2008-2012 was 0.77%, and 1.18% from 2008–2016 (Lark et al., 2020). The water quality changes observed with these associated numbers were of the

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long these areas were covered in grass, and methods for estimating grassland and whether these lands represent long term grassland or areas that are intermittently utilized for pasture, hay, or other lightly managed areas (Dunn et al. 2018, Copenhaver et al. 2021).

same magnitude, as increases in nutrient loads increased by 1.5 times from 2008–2016 compared to 2008–2012[27].

[27] For more information on these results and the baseline scenario used in comparison to the different biofuel scenarios, see Chen et al. (2021)

Figure VIII.A.1.a-1: Fertilizer Application Rates for Different Crops

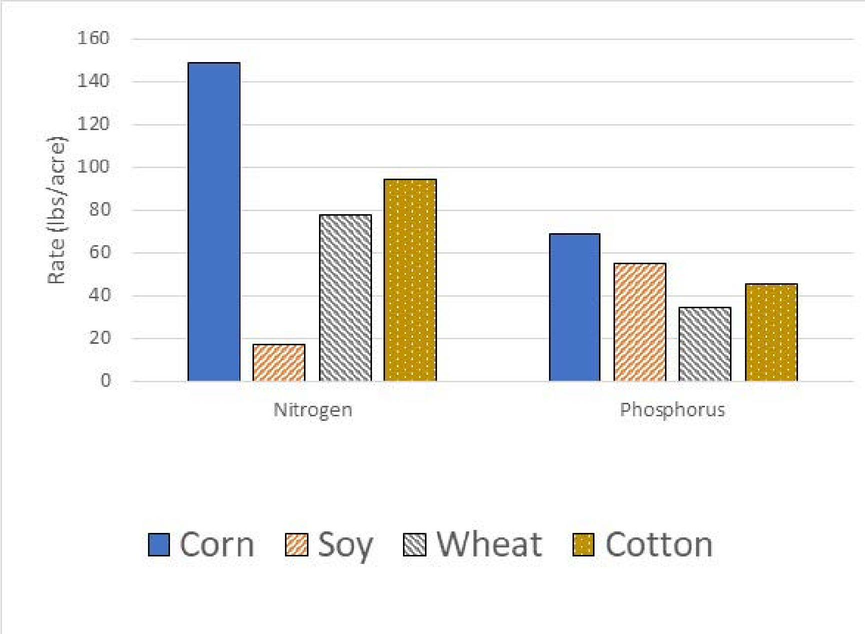
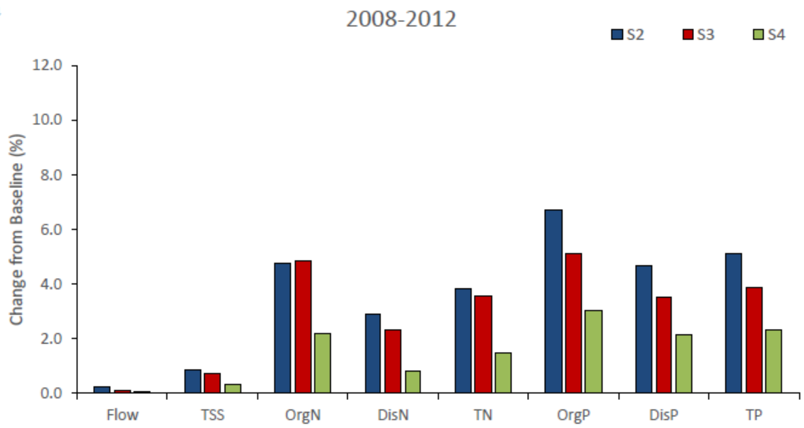
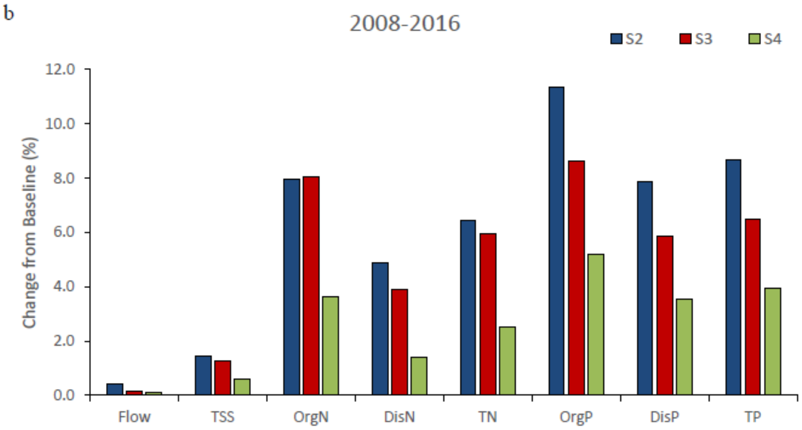


Figure VIII.A.1.a-2: Summary of the Results at the MORB Outlet. Shown are the mean annual changes in flow, total suspended sediment, organic nitrogen, dissolved nitrogen, total nitrogen, organic phosphorus, dissolved phosphorus, and total phosphorus between S1 and the different biofuel/cropland conversion scenarios.

a



b



At the outlet of the MORB, SWAT modeling showed that G to C conversion resulted in the greatest increase in TN and TP loads (6.4% and 8.7%, respectively), followed by G to C/S conversion (6.0% increase in TN and 6.5% increase in TP), and then G to C/W (2.5% increase in TN and 3.9% increase in TP). The greatest percentage increase in TN and TP occurred in the Dakotas, coinciding with the highest amount of grassland conversion. However, because of the relatively low percentage of cropland in these areas, they contributed relatively little TN and TP to total basin loads. Rather, "hotspots" of change predominantly in downstream collecting areas that are also cropland heavy states like Iowa, Missouri, Nebraska, and Kansas, contributed the bulk of TN and TP to basin-wide loads. Loading from existing cropland, grassland conversion, and precipitation are major factors in the contribution of land to nutrient loads. These results have implications for streams within the MORB as well as endangered and threatened species.

While Chen et al. (2021) provides a reasonable explanation for how nitrogen and phosphorus respond to increasing cropland conversion, it does not address how upstream tributaries, including small rivers and streams, may be affected by nearby cropland conversion. While absolute quantities of TN, TP, sediment, and some fertilizers may be higher at river junctions downstream, there is still some concern surrounding waterbodies that are directly adjacent to cropland. Concentrations in these small streams and tributaries can be higher despite lower total loading, as there is less dilution and degradation.

Another area of concern from increasing cropland for biofuel production is the contribution of fertilizers used on this new cropland to hypoxia in the Mississippi River and the Gulf of America. Hypoxia is caused by excess nutrients, most especially nitrogen and phosphorus, entering the water from agricultural runoff and other point sources. These excess nutrients stimulate the growth of algae, which decomposes, consuming oxygen, and leading to fish die-offs and harm to aquatic life. Apart from the SWAT modeling discussed above, we are not aware of any modeling efforts or published efforts that have attempted to estimate the impact of the specific potential cropland increases we estimate could result from the RFS volume requirements in the Set Rule. In the absence of more specific data, we have used the results from the SWAT modeling discussed above to estimate the potential impact of increased crop production on the amount of nitrogen and phosphorus entering the Gulf of America.

The SWAT modeling conducted for the RtC3 estimated the impact of increased cropland in the Missouri River basin observed from 2008–2016, which was similar in magnitude to the increase in cropland we projected could be attributable to the RFS volume requirements in the Set 1 Rule BE, on the nitrogen and phosphorus loads at the mouth of the Missouri River for several scenarios. To inform our understanding of the potential magnitude of this impact, we compared the results of these scenarios to the total nitrogen and phosphorus loads at the Mississippi River outlet. The total nitrogen load has been relatively stable since 1995 at approximately 1.5 million metric tons and the total phosphorus load has been relatively consistent since 2005 at approximately 0.15 million metric tons (Stackpoole et al., 2021). Thus, the modeled increases in total nitrogen (5,400–13,800 tons per year) and total phosphorus (1,500–3,400 tons per year) at the mouth of the Missouri River would represent an increase of 0.3%–0.8% and 0.9%–2.1% of total nitrogen and phosphorus respectively at the outlet of the Mississippi River. This would represent a minor increase in the total hypoxic area expected in the Gulf of America: literature estimates range from a 56 to 80 percent reduction in nutrient loading to achieve a 5000 km^2 reduction in hypoxic area. A 20 percent total load reduction is estimated to reduce hypoxic area between 124,000 km^2 and 156,000 km^2 (Scavia et al., 2017).

These estimates of the percent increase in total nitrogen and phosphorus at the Mississippi River outlet that could potentially result from an increase in cropland to produce biofuels attributable to the RFS volume requirements make several key assumptions. First, they are based on a conservative estimate of land use acreage impacts that could be attributed to the RFS Set 2 Rule. Second, the high end of the ranges presented represent a scenario where all of the new cropland is used to produce continuous corn. As discussed in Section VI, most of the increase in cropland is expected to be used for soybean production. Third, as mentioned above, while Chen et al. (2021) provides a reasonable explanation for how nitrogen and phosphorus respond to increasing cropland conversion, it does not address how upstream tributaries, including small rivers and streams, may be affected by nearby cropland conversion, and how species that occur in such freshwater ecosystems may be impacted by potential effects. EPA completed a qualitative analysis in collaboration with NMFS, as described in Section IX, that examines this more closely for NMFS species. Lastly, the SWAT modeling is of course based on a time frame and biofuel volumes prior to the Set 2 Rule and its proposed volume increases, and therefore likely does not capture the full scope of impacts resulting from this rule. However, the estimates discussed in this section could be mathematically scaled to the different volumes of the

Set 2 Rule, or future rules, to provide a rough approximation of the effects that could potentially be seen from that rule.

b. National Nutrient Inventory Application: Shifts in Agricultural Nutrient Sources Across the United States

The EPA's National Nutrient Inventory (NNI) provides estimates of inputs and outputs of nitrogen and phosphorus across four sectors: atmospheric, agricultural, background/natural, and urban (Brehob et al., 2025; Sabo et al., 2019; Sabo et al., 2021). For this analysis, we extracted data from the NNI's agricultural sector to quantify nitrogen and phosphorus agricultural surplus[28] through time, at the national and HUC12 subbasin scales. Tracking how agricultural nutrient inputs have changed across the United States is critical to understand the impacts of increased agricultural production on water quality over the past 25 years. Agricultural input and output estimates from the NNI are largely empirical, and are based on federal datasets of farmer reported crop yields, acreage, and livestock populations from the USDA Agricultural Census NASS, 2024) and USGS-compiled state/county fertilizer sales reports (Falcone, 2021). Currently, the NNI presents annual data from 1950 to 2017. To better evaluate how agricultural production and nutrient management have evolved during the biofuel production expansion period, trends in agricultural nitrogen and phosphorus surplus were evaluated for 2002 to 2017 (Brehob et al., 2025). Older data were also visualized to provide context for long-term trends.

Although crop nitrogen fixation and fertilizer inputs increased, both agricultural nitrogen and phosphorus surplus remained largely stable at the national level since 2002 (Figure VIII.A.1.b-1). The agricultural nitrogen surplus increased slightly from 12.4 to 13.4 Tg yr^{-1} from 2002 to 2017,[29] whereas phosphorus decreased from 1.92 to 1.68 Tg yr^{-1}. These generally stable surplus trends are because crop yield increased faster than, or at least kept pace with, increased inputs, indicating improved efficiency in leveraging nutrients to grow crops (Figure VIII.A.1.b-1).

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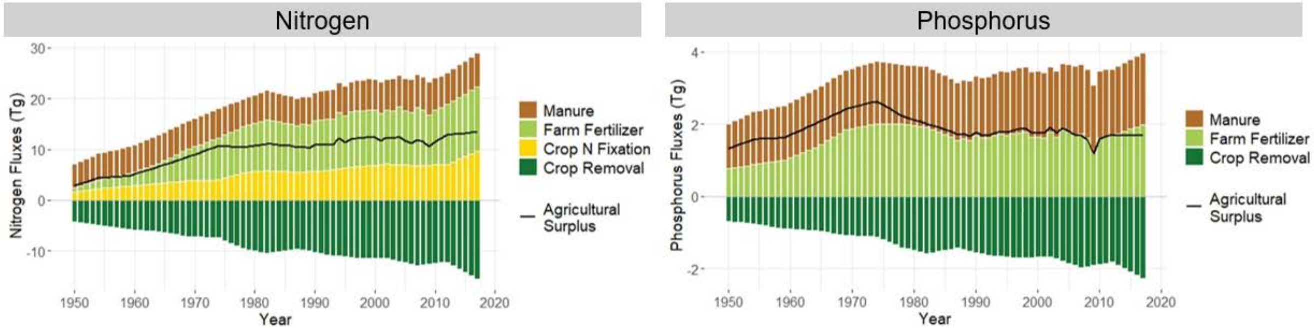
[28] Agricultural Surplus = Total Agricultural Inputs (Manure, Farm Fertilizer, Crop Nitrogen Fixation (only for nitrogen)) – Non-Hydrologic Agricultural Outputs (Crop Removal). This variable measures excess nitrogen that is not utilized for crop production, which could then be potentially released into the environment.

[29] For 2017, the USGS fertilizer estimate is a projection. At time of the USGS data publication, sales data were only available through 2012. Recent release of state level sales data for 2017 highlights that these projections likely overestimated nitrogen and phosphorus application by 8 and 20%, or 1.1 Tg N yr^{-1} and 0.3 Tg P yr^{-1}, respectively. Thus, nitrogen and phosphorus surplus is likely stable to declining in the United States.

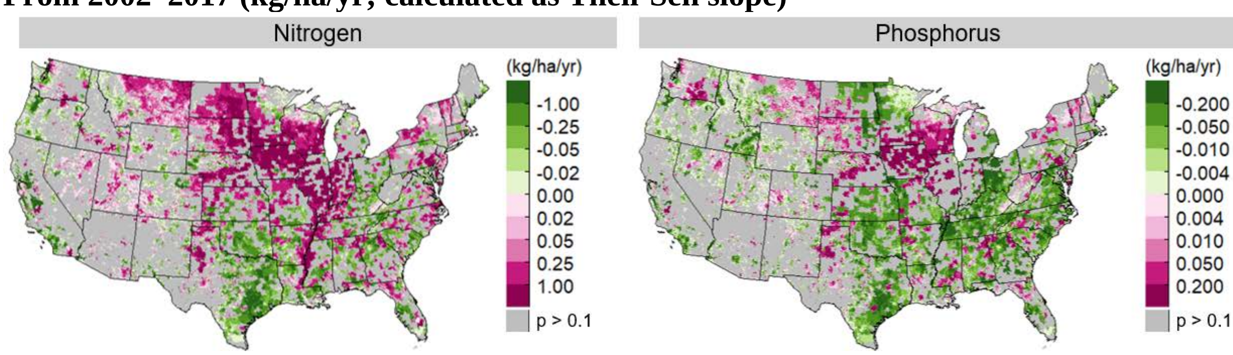
Figure VIII.A.1.b-1: Annual Time Series of Nitrogen and Phosphorous Agricultural Surplus and Relevant Fluxes (Tg yr-1) From 1950–2017



Trends in agricultural surplus were not geographically uniform across the United States from 2002 to 2017 (Figure VIII.A.1.b-2). Corresponding with reported increases in corn and soy acreage on the western fringes of the Corn Belt and more frequent cultivation of these crops in states farther east in the Midwest region, the agricultural nitrogen surplus increased in much of the upper Midwest due to increased fertilizer use and nitrogen fixation[30,31] (US EPA, 2025b). Trends in phosphorus surplus were more spatially variable, but generally more HUC12 subbasins demonstrated a decline or no significant trend compared to those that showed an increase from 2002 to 2017 (Figure VIII.A.1.b-2).

Overall, fertilizer inputs and crop nitrogen fixation have increased due to expansion of livestock production and corn and soy cultivation (US EPA 2025b). Crop nitrogen and phosphorus removal have largely kept pace or exceeded increases in inputs—leading to a relatively stable national agricultural surplus from the 1980s onward. As updated fertilizer sales, livestock population, and crop production/acreage data become available, the NNI will be updated to track how agricultural nutrient sources continue to evolve across the United States.

Figure VIII.A.1.b-2: Maps of Annual Change in Agricultural Surplus in HUC12 Subbasin From 2002–2017 (kg/ha/yr; calculated as Theil-Sen slope)



[30] Currently, debate exists on if nitrogen fixation results in a surplus of nitrogen. To be conservative, the current iteration of the NNI assumes ~20% of fixed nitrogen is left behind on fields. If this conservative assumption was not used, net nitrogen fixation values, and corresponding agricultural surplus values, would be lower.

[31] Some of these HUC12-level trends are influenced by the positive bias in the 2017 fertilizer projection (see footnote 2).

c. Nutrient Condition Summary for the National Lakes Assessment and National Rivers and Streams Assessment

The National Aquatic Resource Surveys (NARS) use stratified random sampling designs to assess the condition of the Nation's waters (lakes, coastal waters, rivers and streams, and wetlands) on recurring five-year cycles. This statistical survey approach randomly identifies sampling locations from a defined population of waterbodies (e.g., lakes, rivers and streams), which allows results from the individually sampled locations to be extrapolated to the larger population. Additionally, the use of standardized sampling and analytical methods for each survey allows NARS to provide comparable results at the national and regional scale. Each survey samples multiple parameters that characterize the physical, chemical and biological condition of the Nation's waterbodies. Each year, sampling is conducted at about 1000 sites during a summer index period (June-September). This analysis is based on results from the National Lakes Assessment (NLA) and National Rivers and Streams Assessment (NRSA).

The NLA and NRSA use ecoregional benchmarks based on the distribution of parameter values at a set of reference sites to assign condition classes (good, fair, poor) to survey sites. As described in detail in the NLA and NRSA web reports (US EPA 2024b, 2024d), EPA chose this regional benchmark approach because lake and river and stream characteristics in different ecoregions vary due to climate, geology and ecology, as well as human disturbance. Use of this type of approach to evaluate surface water condition is well-supported by the available science (Stoddard et al., 2006). The NLA and NRSA technical support documents describe reference site selection and provide parameter-specific details about benchmarks, criteria, and screening levels (US EPA 2024a, 2024c).

NLA cycles have shown that nutrient pollution is consistently a widespread stressor. The percentage of the Nation's lakes in poor condition for total phosphorus in 2012, 2017, and 2022 was 44, 45 and 50%, respectively (Figure VIII.A.1.c-1) and for total nitrogen was 41, 46 and 47% (Figure VIII.A.1.c-2). No significant differences ($p \leq 0.05$) were observed across these three cycles, suggesting lake nutrient concentrations have remained generally stable. Approximately 42% of the Nation's lakes occur in the Mississippi River Basin (MRB, Figure VIII.A.1.b-3) and results for lakes in the MRB were similar to the national results (can be visualized at https://nationallakesassessment.epa.gov/dashboard). The percentage of lakes in the MRB in poor condition for total phosphorus in 2012, 2017, and 2022 was 49, 50 and 60%, respectively and for total nitrogen was 51, 49 and 52% with no significant trends over time or changes between cycles.

Nutrient pollution in the Nation's rivers and streams has also been a widespread and consistent issue. The percentage of the nation's river and stream miles in poor condition for total phosphorus in 2008/2009, 2013/2014, and 2018/2019 was 51, 59 and 42%, respectively (Figure VIII.A.1.c-4). While there was no significant trend across the three cycles, there was a statistically significant decrease in the percentage of rivers and streams in poor condition for total phosphorus between the 2013/2014 and 2018/2019 cycles (18 percentage point decrease) and also between 2008/2009 and 2018/2019 (9 percentage point decrease). For both time periods, the decrease in poor condition was accompanied by a statistically significant increase in good condition for total phosphorus. There was no change over the three survey cycles in the percentage of the Nation's rivers and streams in poor condition for total nitrogen (44% in all three cycles, Figure VIII.A.1.c-5).

Approximately 52% of the extent of the Nation's rivers and streams occur in the MRB and results were similar for rivers and streams in the MRB (can be visualized at https://riverstreamassessment.epa.gov/dashboard). The percentage of rivers and streams in the MRB in poor condition for total phosphorus during the three NRSA cycles was between 51 and 66%. Similar to the national results, there was a statistically significant decrease of 15 percentage points (66% to 51%) in rivers and streams in poor condition for total phosphorus between 2013/2014 and 2018/2019 and a 15% increase (16.5% to 31.5%) in rivers and streams in good condition. There was minimal change in total nitrogen in the MRB, with the percentage of river and stream miles in poor condition for total nitrogen consistently around 52 to 53%.

The NLA and NRSA have shown that nutrient pollution is widespread, with a consistently high percentage of the nation's lakes and rivers and streams in poor condition for nutrients across three survey cycles. The results are similar when focusing on lakes and rivers and streams in the MRB. When analyzing change between survey cycles, there was a significant decrease in the percentage of rivers and streams in poor condition for total phosphorus between the 2013/2014 and 2018/2019 cycles (nationally and MRB) and between the 2008/2009 and 2018/2019 cycles (nationally).

Figure VIII.A.1.c-1: Change in the Percentage of the Nation's Lakes in Each Total Phosphorus Condition Category for 2012, 2017, and 2022

Figure VIII.A.1.c-2: Change in the Percentage of the Nation's Lakes in Each Total Nitrogen Condition Category for 2012, 2017, and 2022

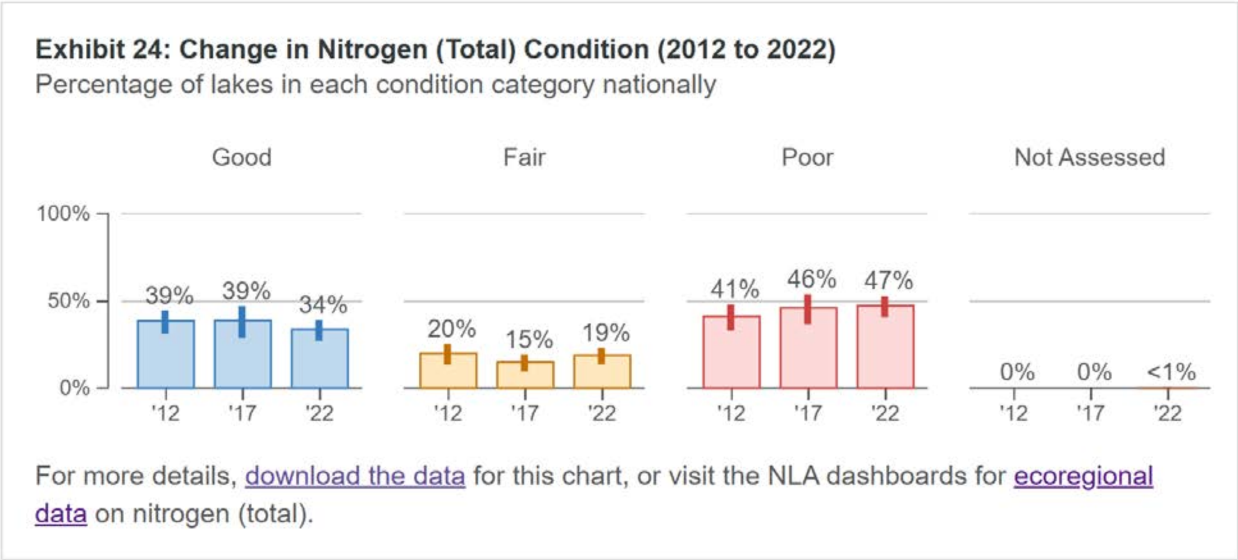
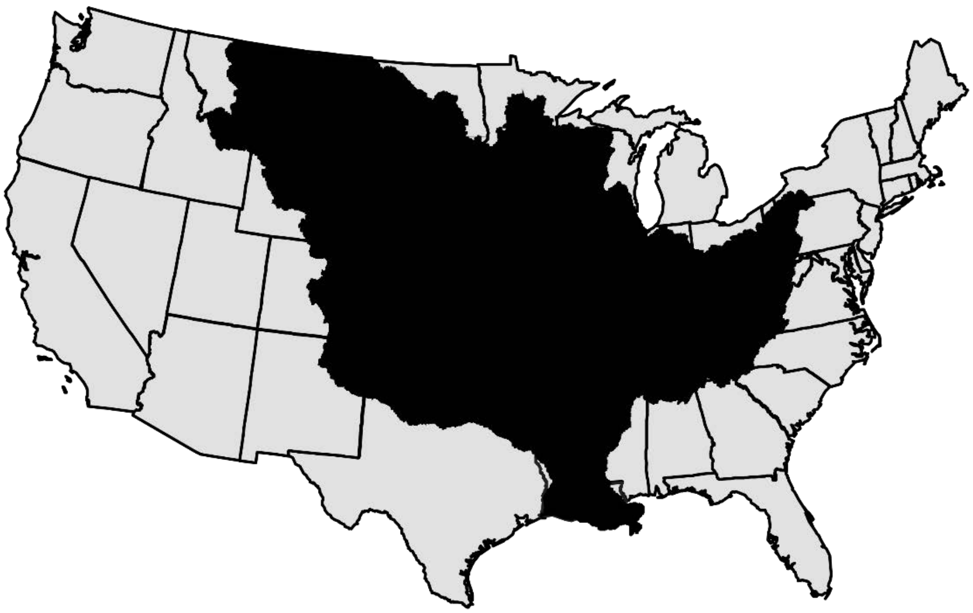


Figure VIII.A.1.c-3: Map of the Mississippi River Basin



The black area shows the Mississippi River Basin (NARS findings can be visualized at https://riverstreamassessment.epa.gov/dashboard).

Figure VIII.A.1.c-4: Change in the Percentage of the Nation's Rivers and Streams in Each Total Phosphorus Condition Category for 2008–2009, 2013–2014, and 2018–2019

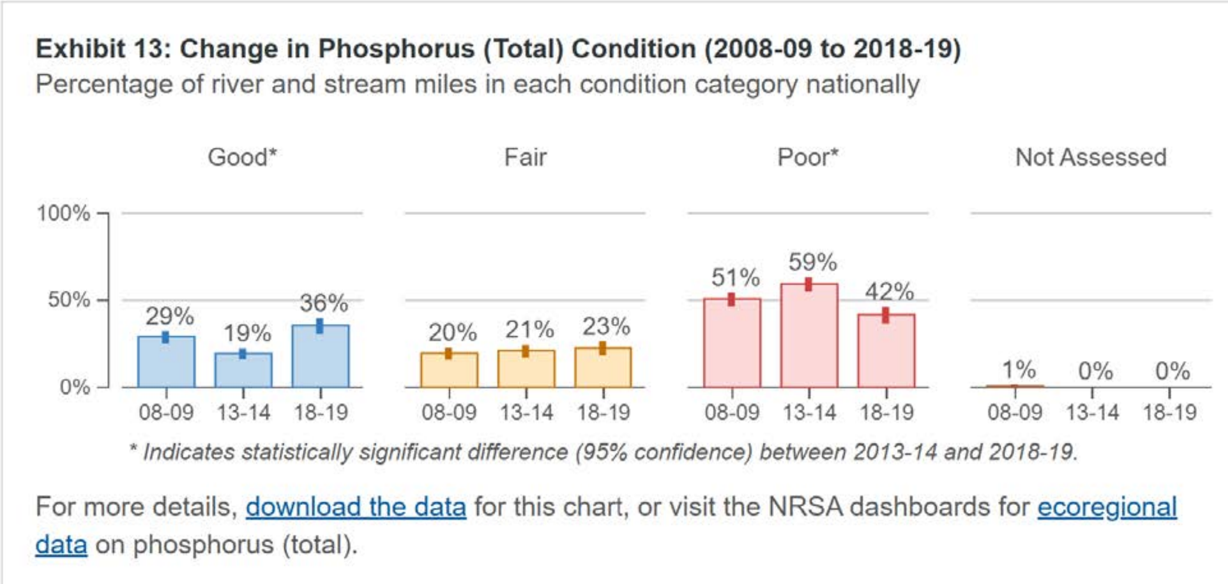
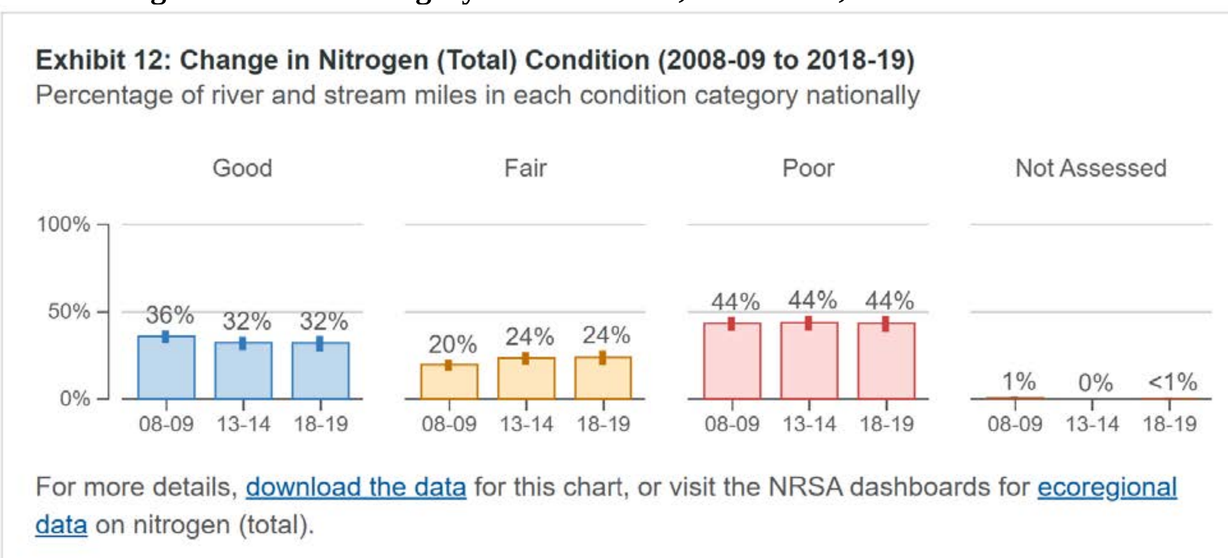


Figure VIII.A.1.c-5: Change in the Percentage of the Nation's Rivers and Streams in Each Total Nitrogen Condition Category for 2008–2009, 2013–2014, and 2018–2019



d. Trends in Watershed Export of Sediment, Total Nitrogen, and Total Phosphorus

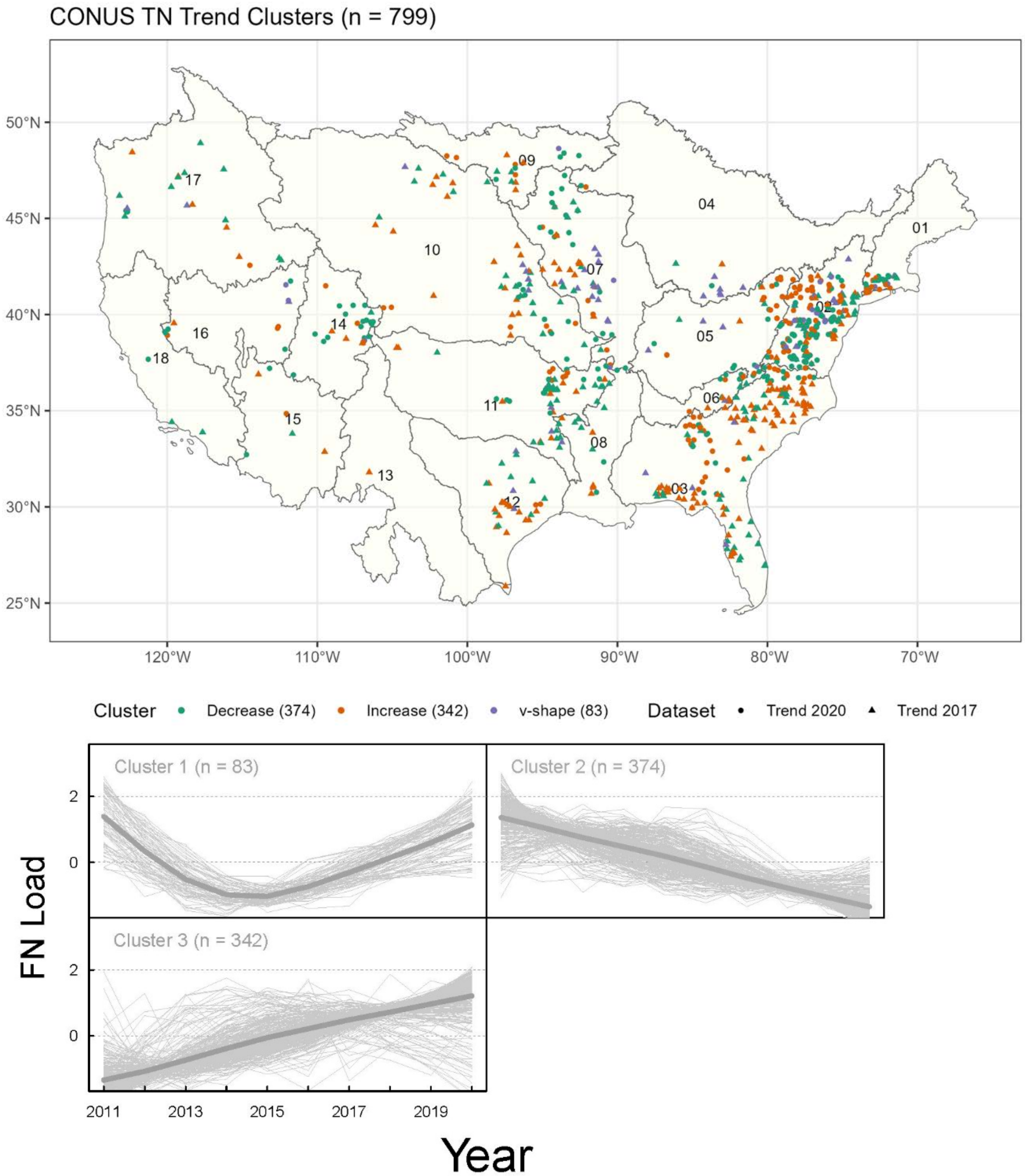
The primary objective of this analysis is to identify regional water quality trend patterns for key parameters—Total Nitrogen (TN), Total Phosphorus (TP), and Suspended Sediment Concentration (SSC). The analysis draws upon a robust, spatially extensive dataset compiled from two recent USGS riverine trend data releases, the 2020 and 2017 datasets (Goodling et al., 2024; Murphy Blair et al., 2021), which together offer broad geographic and temporal coverage. The consolidated data include 799 stations for TN, 829 stations for TP, and 228 stations for SSC across the CONUS. Using paired stream gage and water quality observation data, the Weighted

Regressions on Time, Discharge, and Season (WRTDS) method was applied to estimate flow-normalized loads for each station, which effectively removes the effect of inter-annual variability in streamflow on loads. These flow-normalized loads were standardized then used to run hierarchical clustering to group short-term trends (approximately 2011–2020) into distinct trend groups. While statistical metrics often suggested two clusters as optimal, three were selected for TN, TP, and SSC to ensure interpretability and consistency with prior work (Zhang et al. 2022). These three clusters—"monotonic increase," "monotonic decline," and "V-shape (or opposite)"—are straightforward to interpret, though the latter two may be consolidated into a single "non-declining" group as supported by the dendrograms.

For TN, three primary trend clusters emerged (Figure VIII.A.1.d-1). The first cluster (83 stations) exhibited a v-shaped pattern, with nitrogen export initially decreasing and then increasing toward the end of the study period. The second and largest cluster (374 stations) showed consistent declines over time, indicating broad improvements in water quality conditions. The third cluster (342 stations) experienced steady increases over time, suggesting that some regions remain under pressure from land use changes, intensified agriculture, or other watershed factors. Patterns for TP were similar but also showed key differences (Figure VIII.A.1.c-2). Of the 829 stations analyzed, 361 exhibited increasing TP export, 422 showed a clear decreasing trend, and 46 displayed an increase-and-then-decrease pattern. For SSC (Figure VIII.A.1.c-3), 69 stations showed increasing exports, 133 showed consistent decreases, and 25 showed an increase-and-then-decrease trend. Across all three parameters, trends were generally evenly distributed across watersheds of all sizes and mean loading rates.

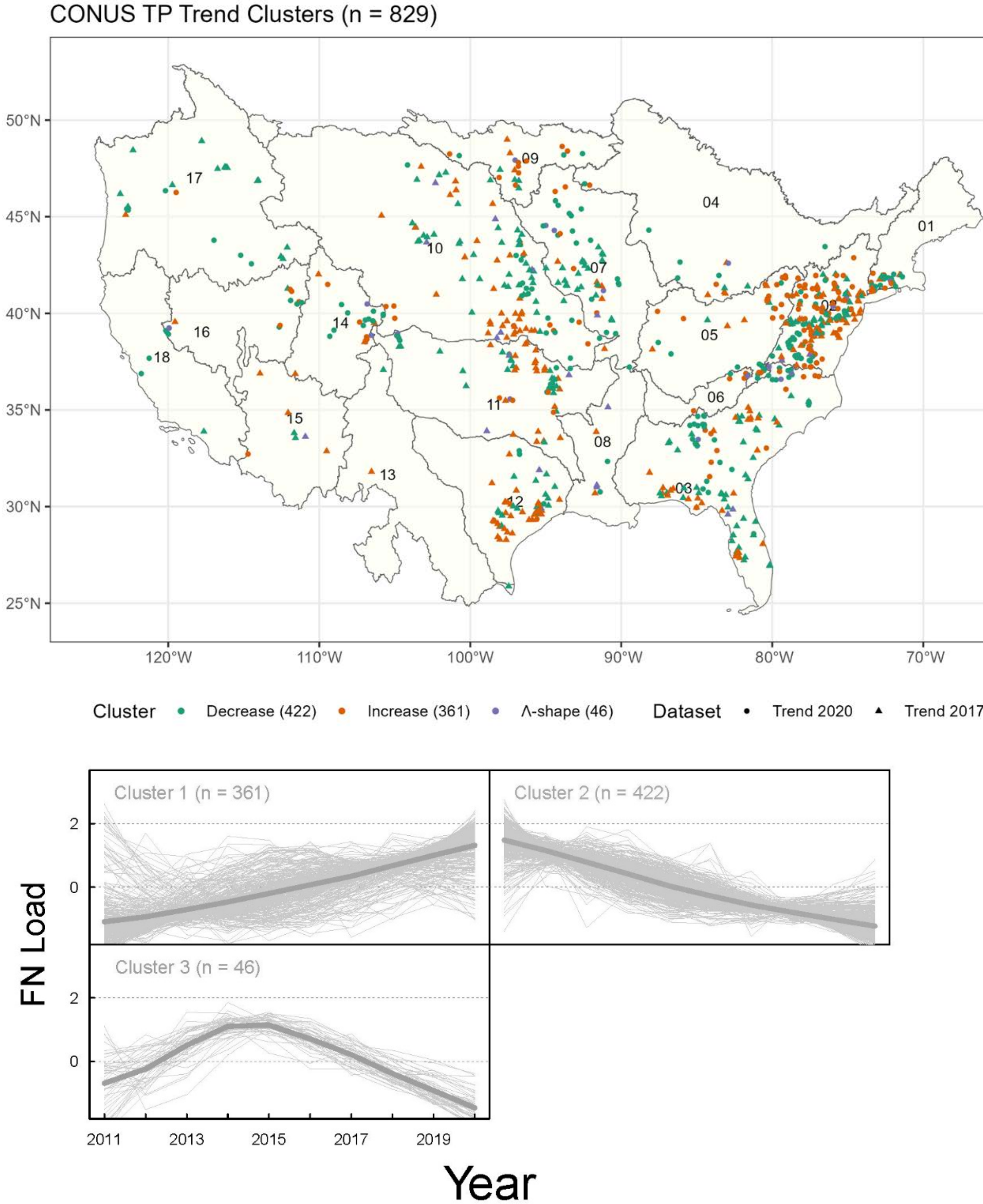
This analysis indicates that declining TN, TP, and SSC loading trends are more common than v-shaped or increasing trends at individual stations, yet it is not entirely clear how this variability manifests itself at larger watershed scales and if a net decline in nitrogen and phosphorus loads is occurring. Since most cropland expansion and intensification has occurred in the Mississippi River Basin and has the potential to influence the Gulf of America dead zone, we also report USGS estimates of flow-normalized TN and TP since 1979 but focus on the post-2000 period (Figures VIII.A.1.d-4 and 5, USGS 2025). This additional exploratory analysis integrates the variability in subwatershed trends across MS basin, which drains about 41% of the United States, and helps better quantify the magnitude of changes in loads. Time series graphics of WRTDS flow-normalized TN and TP loads are publicly available from the USGS. These time series provide annual estimates of load for 1979 through 2024 (Figures VIII.A.1.d-4 and 5); this analysis solely focuses on the post-2000 period. Since the mid-2000s, flow-normalized TN export has declined from 1.5 million tons to ~1.25 million tons. Flow-normalized TP export has remained generally stable at 150-175 thousand tons since 2000. Thus, from ~2000-onward, no discernable increases in flow-normalized TN or TP export were detected for the Gulf of America based on visual interpretation of the trends. However, the change in flow-normalized TP loads between the baseline period (1980 - 1996) and 2024 was estimated to increase 9% (+10% likely due to changes in upstream P sources, and -1% due to a long-term change in streamflow) (Figure VIII.A.1.d-5).

Figure VIII.A.1.d-1: Map of the Three Trend Clusters in Flow-Normalized Total Nitrogen (TN) Loads Across the Contiguous United States (CONUS) for the Recent 10-Year Period of Approximately 2011–2020



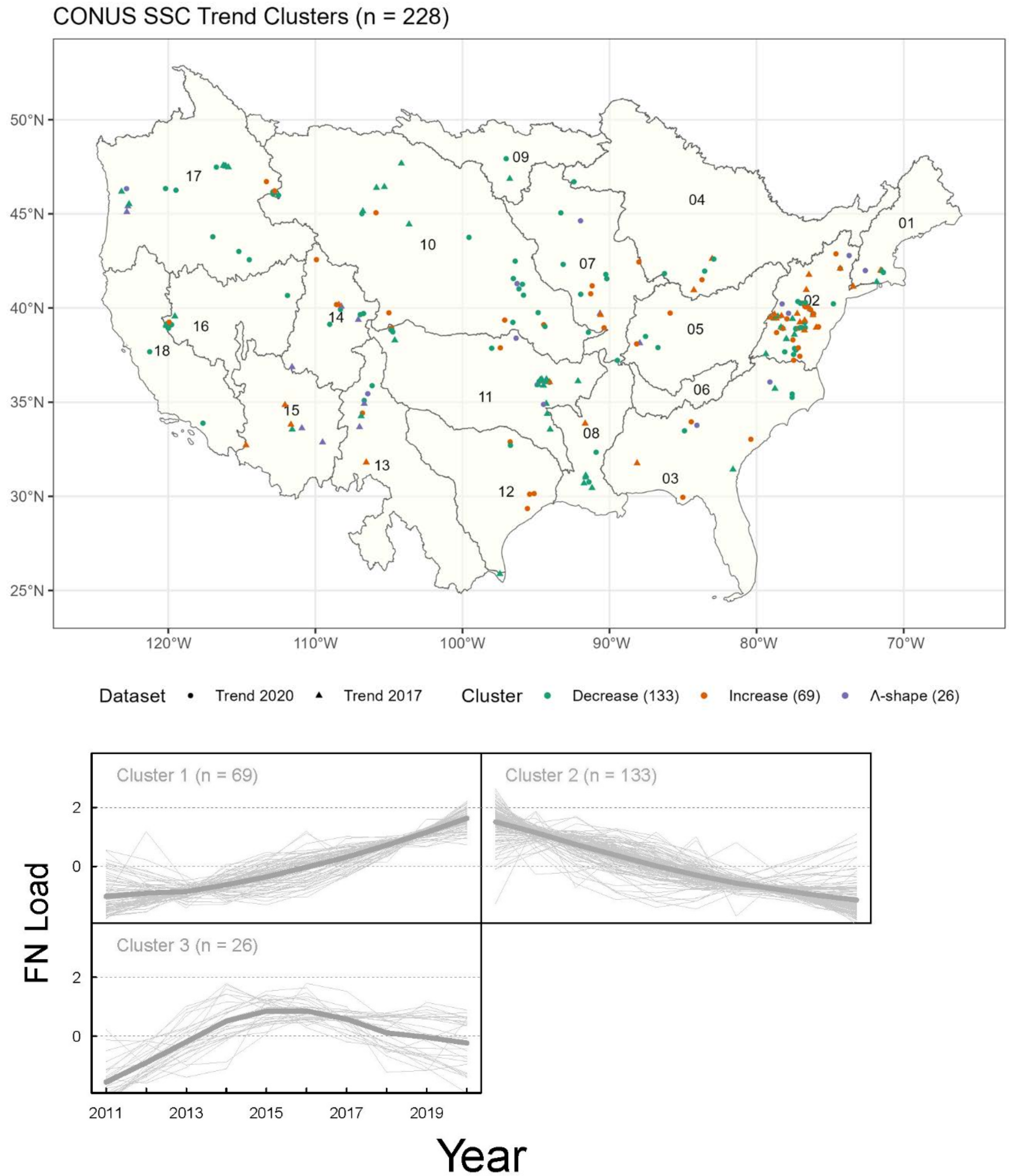
Note: Numbered polygons delineate major HUC2 subbasins. The lower panel shows the flow-normalized load trajectories for each cluster, with thick lines representing cluster-level trends and thin lines representing individual station-level trends. Based on the cluster dendrogram, the two non-declining clusters (clusters 1 and 3) could also be consolidated into a single group.

Figure VIII.A.1.d-2: Map of the Three Trend Clusters in Flow-Normalized Total Phosphorus (TP) Loads Across the Contiguous United States (CONUS) for the Recent 10-Year Period of Approximately 2011–2020



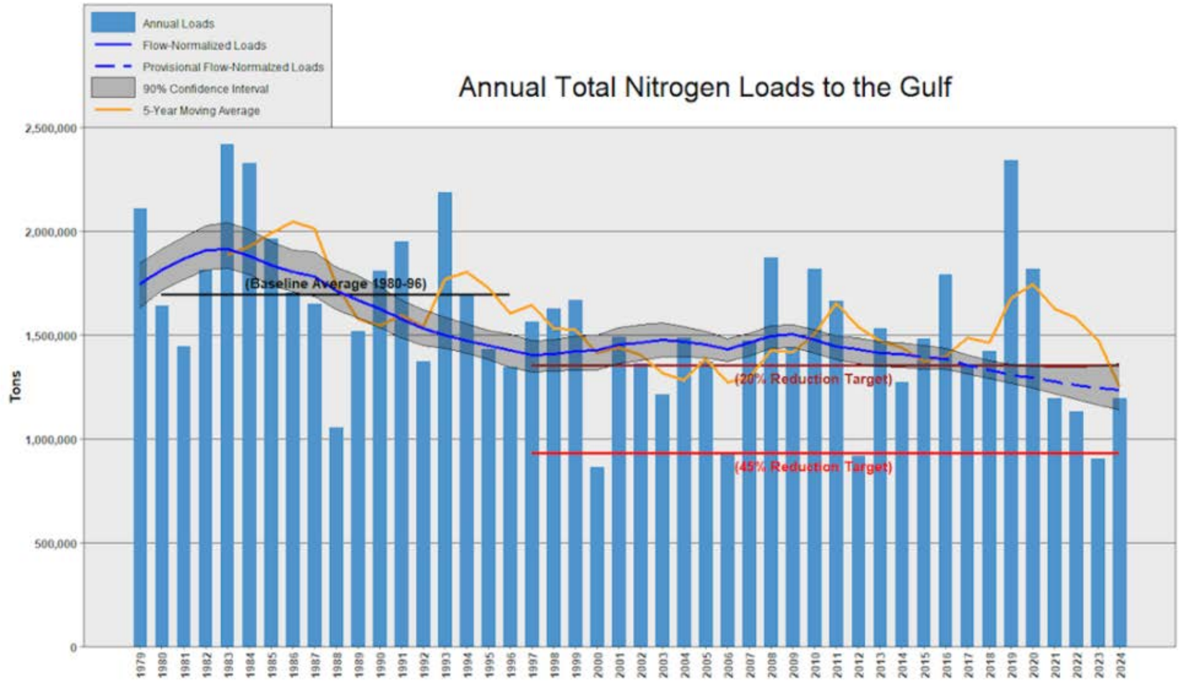
Note: Numbered polygons delineate major HUC2 subbasins. The lower panel shows the flow-normalized load trajectories for each cluster, with thick lines representing cluster-level trends and thin lines representing individual station-level trends. Based on the cluster dendrogram, the two non-declining clusters (clusters 1 and 3) could also be consolidated into a single group.

Figure VIII.A.1.d-3: Map of the Three Trend Clusters in Flow-Normalized Suspended Sediment Loads Across the Contiguous United States (CONUS) for the Recent 10-Year Period of Approximately 2011–2020



Note: Numbered polygons delineate major HUC2 subbasins. The lower panel shows the flow-normalized load trajectories for each cluster, with thick lines representing cluster-level trends and thin lines representing individual station-level trends. Based on the cluster dendrogram, the two non-declining clusters (clusters 1 and 3) could also be consolidated into a single group.

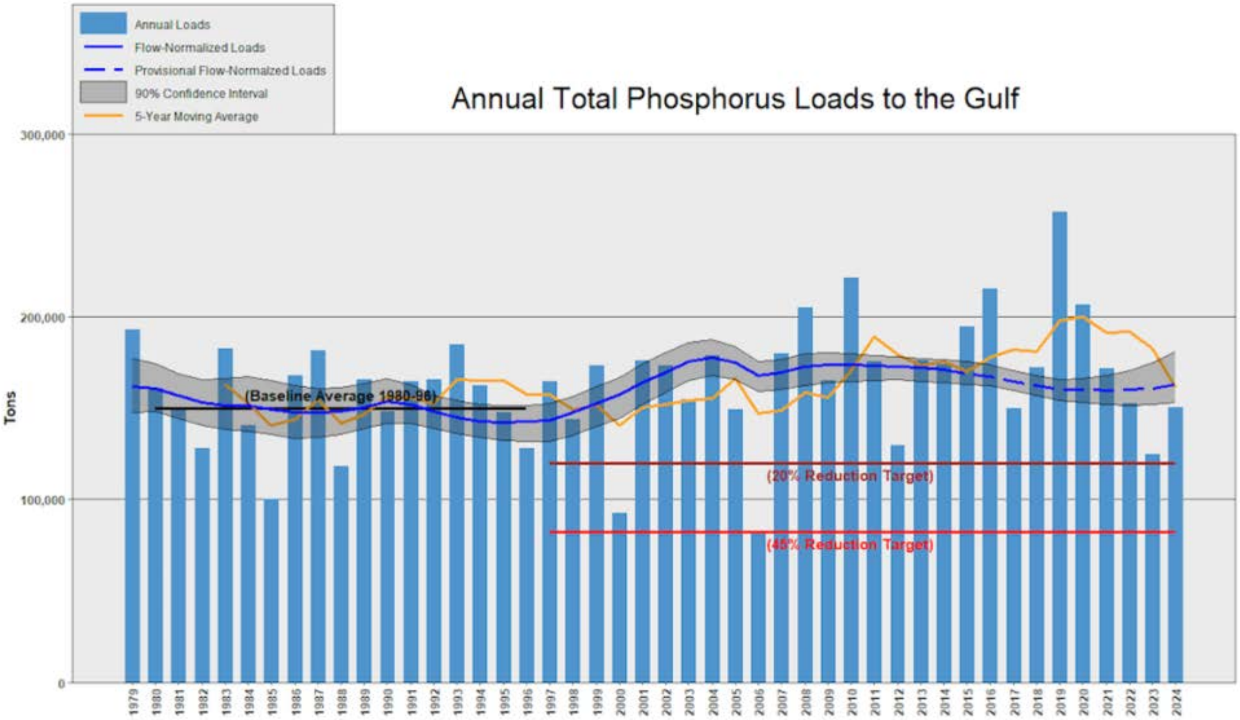
Figure VIII.A.1.d-4: Time Series of WRTDS True Condition and Flow-Normalized Annual Loads of Total Nitrogen (TN) to the Gulf of America



Trend start period	Trend end year	Trend, in percent change	Lower 90% confidence interval	Upper 90% confidence interval	Trend attributed to changes in streamflow	Trend attributed to other changes in the watershed
1980-1996	2024	-27%	-36%	-19%	0%	-27%

Note: Data/figure courtesy of USGS, 2025. For this analysis, we focus on visually interpreting trends post-2000 but provide historical data of Hypoxia Task Force progress towards for greater context.

Figure VIII.A.1.d-5: Time Series of WRTDS True Condition and Flow-Normalized Annual Loads of Total Phosphorus TP) to the Gulf of America



Trend start period	Trend end year	Trend, in percent change	Lower 90% confidence interval	Upper 90% confidence interval	Trend attributed to changes in streamflow	Trend attributed to other changes in the watershed
1980-1996	2024	9%	-5%	19%	-1%	10%

Note: Data/figure courtesy of USGS, 2025. For this analysis, we focus on visually interpreting trends post-2000 but provide historical data of Hypoxia Task Force progress for greater context.

Overall, the historic nutrient trends analyses show there are no major nationwide trends in agriculture nutrient sources, growing season nutrient concentrations, or watershed export of sediment, total nitrogen, and total phosphorous. Smaller or more regional watershed analysis may show different results, but as the Set 2 Rule is a national rule and it is difficult to predict with certainty where cropland conversion will take place as a result of the rule and not other factors, this analysis was conducted on the national scale. Crop removal, crop nitrogen fixation, and livestock production have continued to increase since the early 2000s, but agricultural nutrient surplus has largely plateaued since the 1970s and 1980s. Nitrogen surplus did slightly increase from 2002 to 2017, but phosphorous surplus decreased in that same time period. For the NARS Survey analysis, nutrient pollution is shown to be the most widespread stressor on national rivers, streams, and lakes. For rivers and streams, nitrogen remained stable and phosphorous pollution generally decreased from 2013 to 2019. For lakes, there was no observable change in nitrogen or phosphorous pollution for the same time period. Overall, although some regional or subpopulation level differences were observed, surface water nutrient concentrations show that no major and sustained differences have been observed across the 2008 to 2022 time period. Finally, the watershed export trend evaluation showed that nutrient loading trends are variable, but more stations observed recent declines in watershed export. Sediment export is also declining at most stations, and nitrogen exported from the Mississippi River Basin to the Gulf continued to decline during the biofuel expansion period while phosphorous remained generally stable.

In conclusion, we believe the multiple historical nutrient analyses discussed above, along with the SWAT modeling used in past RFS biofuel modeling efforts, provides a more comprehensive insight into the potential water quality impacts from biofuel expansion, which can be extrapolated to the volumes in the Set 2 Rule. As previously mentioned, we are not aware of any modeling or published efforts that have attempted to estimate the impact of the specific potential cropland increases we estimate could result from the RFS volume requirements in the Set Rules. The SWAT modeling shows highly conservative but specific estimates of potential water quality impacts from volumes of biofuel production prior to 2021 in the Missouri River Basin, while the historic nutrient trend analyses use spatial and statistical analysis to demonstrate there are few, if any, recent increases in nutrient loading correlated to the increasing growth of crops on a national scale, to which biofuel feedstock expansion contributes. While both analyses have uncertainties, they make use of a combination of data and methods to provide a more comprehensive overview of fertilizer impacts on water quality potentially correlated to biofuel expansion.

2. Estimated Potential Impacts of Increased Pesticide Use

Listed species can also be impacted by a variety of pesticides that are commonly used in the production of biofuel crops such as corn and soybeans. Any increase in crop production that is attributable to the RFS volume requirements could therefore potentially impact listed species if the pesticides applied to this cropland was transported to local waterways and then downstream to larger streams and rivers. To consider the potential impact of increased use of pesticides we first identified the 15 most commonly used pesticides applied to corn, soybeans, and wheat (based on percent of crop acres treated). While wheat is not commonly used to produce biofuel in the US, the modeling conducted in support of the canola renewable diesel pathway indicated that an increase in wheat production is likely as increasing demand for canola renewable diesel resulted in canola displacing wheat in Canada, causing additional wheat production in North Dakota.

After identifying the 15 pesticides most likely to be applied to corn, soybeans, and wheat we identified a movement rating, soil half-life, and aquatic half-life for each of the pesticides that was one of the top 15 most widely used pesticides for at least one of the three crops (Table VIII.A.2-1).[32] These characteristics inform the likelihood that the pesticides will transport from the field on which they are applied and end up on local waterways or streams and rivers downstream of new cropland. The movement rating of a pesticide indicates how likely the pesticide is to move in a solution with water below the root zone or to a field edge. Pesticides

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[32] Information on the mobility rating, soil half-life, and aquatic half-life are summarized in the table below. Information in this table was collected from the University of Hertfordshire Pesticide Properties Database (http://sitem.herts.ac.uk/aeru/ppdb/), Oregon State University Pesticide Properties Database (http://npic.orst.edu/ingred/ppdmove.htm) and Pesticideinfo.org (https://pesticideinfo.org/).

with higher movement ratings are more likely to move from the field on which they are applied to local waterways and are more likely to move from these local waterways to downstream rivers. Half-life is the time it takes for certain quantity of a pesticide to be reduced by half as it breaks down in the environment—whether that is in soil (soil half-life) or in water (aquatic half-life). Pesticides with higher movement ratings and/or longer half-lives are generally of greater concern, as these pesticides are more likely to be transported from the fields on which they are applied to waterways and will remain in waterways for more time when they reach the waterway.

Table VIII.A.2-1: Physical Properties of Pesticides Used for Corn, Soybeans, and Wheat

			Half-Life (Days)		2016 - 2020 Average Percent Applied			Average Quantity Applied (lbs/acre)		
Pesticide	Category	Movement Rating	Soil	Hydrolysis	Corn	Soy	Wheat	Corn	Soy	Wheat
2,4-D	Herbicide	Moderate	5-30	39	14%	19%	23%	0.06	0.13	0.13
ACETOCHLOR	Herbicide	Moderate	14	NA	30%	<9%	<6%	0.42	0.06	-
ATRAZINE	Herbicide	High	60	30	60%	<9%	<6%	0.62	0.01	0.00
AZOXYSTROBIN	Fungicide	Moderate/Low	78	31	7%	<9%	<6%	0.00	0.01	0.00
BICYCLOPYRONE	Herbicide	High	213	NA	7%	<9%	<6%	0.00	-	0.00
BROMOXYNIL	Herbicide	Very/Extremely Low	7	NA	<7%	<9%	16%	0.00	-	0.03
CHLORIMURON	Herbicide	High	40	NA	<7%	13%	<6%	-	0.00	-
CHLORSULFURON	Herbicide	High	10	1230	<7%	<9%	6%	-	-	0.00
CLETHODIM	Herbicide	Moderate	0.55	30	<7%	12%	<6%	0.00	0.01	-
CLOPYRALID	Herbicide	Very High	40	30	17%	<9%	10%	0.01	-	0.01
CLORANSULAM-METHYL	Herbicide	Moderate	11	175	<7%	10%	<6%	-	0.00	-
DICAMBA	Herbicide	Very High	14	30	18%	24%	11%	0.03	0.14	0.02
FLUMETSULAM	Herbicide	Moderate	45	NA	11%	<9%	<6%	0.00	0.00	-
FLUMIOXAZIN	Herbicide	Low	22	1	<7%	13%	<6%	0.00	0.01	-
FLUROXYPYR	Herbicide	Moderate	13	223	<7%	<9%	17%	0.00	-	0.02
FOMESAFEN	Herbicide	Very High	100	NA	<7%	21%	<6%	0.00	0.04	-
GLUFOSINATE	Herbicide	Low	7	NA	<7%	16%	<6%	0.01	0.09	-
GLYPHOSATE	Herbicide	Extremely Low	47	35	76%	81%	25%	0.81	1.08	0.38
IMAZETHAPYR	Herbicide	High - Very High	60 - 90	30	<7%	11%	<6%	0.00	0.01	-
ISOXAFLUTOLE	Herbicide	Moderate	0.9	NA	9%	<9%	<6%	0.00	-	-
LAMBDA-CYHALOTHRIN	Insecticide	Extremely Low	30	NA	<7%	9%	<6%	0.00	0.00	0.00
MCPA	Herbicide	Low - High	14 - 25	NA	<7%	<9%	12%	-	-	0.04
MESOTRIONE	Herbicide	Moderate	19.6	30	39%	<9%	<6%	0.04	0.00	-
METOLACHLOR/S-METOLACHLOR	Herbicide	High	90	200	30%	22%	<6%	0.35	0.26	-
METRIBUZIN	Herbicide	High	40	4760	<7%	19%	<6%	0.00	0.05	-
METSULFURON	Herbicide	High	30	NA	<7%	<9%	14%	-	-	0.00
PROPICONAZOLE	Fungicide	Moderate	110	30	7%	<9%	21%	0.01	0.00	0.01
PROTHIOCONAZOLE	Fungicide	Low	14.1	30	<7%	<9%	8%	0.00	0.00	0.01
PYRASULFOTOLE	Herbicide	Moderate	55.5	NA	<7%	<9%	9%	-	-	-
PYROXASULFONE	Herbicide	Moderate	22	NA	<7%	13%	<6%	0.00	0.02	0.00
SULFENTRAZONE	Herbicide	Mobile	541	291	<7%	21%	<6%	0.00	0.04	-
TEBUCONAZOLE	Fungicide	Low	63	28	<7%	<9%	15%	0.00	0.00	0.01
TEMBOTRIONE	Herbicide	Moderate	14.5	30	8%	<9%	<6%	0.01	-	-
THIENCARBAZONE-METHYL	Herbicide	Moderate	11.6	146	8%	<9%	12%	0.00	-	0.00
THIFENSULFURON	Herbicide	Moderate	12	NA	<7%	<9%	12%	0.00	0.00	0.00
TRIBENURON METHYL	Herbicide	Moderate	12	16	<7%	<9%	<6%	-	0.00	0.00

The SWAT modeling conducted in support of the RtC3 considered the impact of increased cropland on several contaminants that could affect listed species such as total suspended sediment, nitrogen, and phosphorus; the SWAT modeling did not consider the impact of increased use of pesticides. While the SWAT model is capable of modeling changes in pesticide concentrations expected to result from increased cropland for some pesticides, we are not aware of any existing SWAT modeling that explored the changes in pesticide concentrations that would be expected to result from the renewable fuel volume production increases or the land use changes we have estimated to potentially result from the Set 2 Rule.

Nevertheless, we believe we can leverage the results of the SWAT modeling conducted for the RtC3 in the Missouri River Basin to inform our understanding of potential impacts of the RFS volume requirements in the Set Rule. As discussed previously, the SWAT modeling conducted for the RtC3 modeled changes in nitrogen, phosphorus, and total suspended solids from an observed increase in cropland that is comparable to what we have estimated could potentially result from the RFS volume requirements in the Set 2 Rule. Nitrogen, phosphorus, and suspended solids are not perfect analogs to the pesticides we think will be used in increasing quantities as the result of the Set 2 Rule. However, they do share some important similarities.

Nitrogen and phosphorus application rates vary by crop type and the characteristics of the cropland, but on average we would expect that the total application of nitrogen and phosphorus in the Missouri River basin is proportional to the increase in total cropland (e.g., a 10% increase in cropland would result in a 10% increase in the quantity of nitrogen and phosphorus applied to cropland across the entire area). Similarly, we would expect that, while pesticides are not universally applied to all new cropland, the increase in pesticide applications would be proportional to the increase in new cropland.

Further, nitrogen and phosphorus have differing mobilities. Nitrogen has a very high mobility and is therefore a reasonable surrogate for pesticides with similarly high mobilities. Phosphorus has a much lower mobility and is therefore a reasonable surrogate for pesticides with lower mobilities. With regard to aquatic half-life (i.e., how mobile they are in the water as opposed to on land), some pesticides may have aquatic half-lives that are comparable to the aquatic half-life of nitrogen or phosphorus.

Using the SWAT modeling results for nitrogen and phosphorus as surrogates for the impact of pesticides on water quality, we would expect any modeling to show similar changes in pesticide concentrations as a result of the RFS volume requirements. As with nitrogen and phosphorus, we would expect to see the greatest increases in pesticide total load at the mouth of the Missouri River downstream of the expected areas of conversion to cropland. Tributaries would see smaller overall increases, but greater overall changes in concentration.

Small, upland tributaries within the MORB and the Mississippi/Atchafalaya River Basin (MARB) (for example in North and South Dakota) are of concern, despite the relatively low absolute total increase in nitrogen and phosphorus seen in them. These areas, according to Chen et al., saw the greatest percentage increase in TN and TP due to grassland conversion into cropland. However, this also coincided with the largest amount of new cultivation in the entire MORB, much of which is not attributable to the RFS. As discussed in more detail in EPA's external review draft of the *Biofuels and the Environment: Third Triennial Report to Congress*, subbasins still maintained TSS, TP, and TN levels well below what is considered impactful to species, and well below that of the outlet of the MORB and other hotspots (US EPA, 2023a). Further, as noted previously, these waterways are already impacted by pesticide use from existing cropland and other land uses.

Beyond the Missouri River basin, we may also expect to see new cropland in other watersheds, but likely to lesser extent relative to the MORB. This is both because the Missouri River basin is the region in which we have seen the greatest conversion of non-cropland to cropland in recent years and because it contains a greater number of acres within the area of potential land use change (depicted in Figure IV.B.3-2) than any other HUC2 region in the U.S. (US EPA, 2023b). This means that, in the probabilistic analyses we conducted to assess potential land use changes from increases in corn ethanol from the Set 2 Rule, there would be a higher chance of lands being randomly selected for conversion in the MORB relative to other regions as there is more land for the model to choose from within the MORB. We may also expect some potential land use changes and subsequent water quality effects to occur primarily in the broader Mississippi region, as depicted with the relatively higher area of potential land use change as a percent of total area for several HUC2 watersheds in that region (US EPA, 2023b) as well as the potential soybean expansion areas explained in other sections of this BE. However, it is important to recognize that potential land use changes from the RFS Set 2 Rule, especially due to increases from corn ethanol, could still occur in the other watersheds (e.g., Chesapeake Bay region), and understanding species' occurrence in those regions and potential responses to water quality-related effects is key to making species determinations for this BE. To explore this further, the EPA worked with NMFS on a qualitative analysis that was based on the corn ethanol probabilistic results for NMFS species. This additional analysis is explained in more detail in Section IX.

B. Ongoing Mitigation Efforts

While the RFS volumes could potentially result in increases in the quantities of fertilizers and pesticides present in waterways, particularly in waterways located near the expected areas of cropland expansion, the EPA is currently implementing a number of programs intended to reduce these types of impacts and to improve water quality. These efforts are not directly related to the RFS program, but the ongoing efforts to reduce the impact of agriculture on water quality and to generally improve overall water quality are expected to reduce the impacts on water quality discussed in the preceding sections.

One of the programs the EPA implements to improve water quality is the establishment of Total Maximum Daily Loads (TMDLs) for impaired waters. Under Section 303(d) of the Clean Water Act, each state must develop TMDLs for all the waters identified on their Section 303(d) list of impaired waters, according to their priority ranking on that list. TMDLs are the calculation of the maximum amount of a pollutant allowed to enter a waterbody, including from both point sources and non-point sources, so that the waterbody will meet and continue to meet water quality standards for that particular pollutant. TMDLs determine a pollutant target, allocate loads to the source(s) of the pollutant, and identify reductions needed to meet those loads. The TMDL process is important for improving water quality because it serves as a link in the chain between water quality standards and implementation of control actions designed to attain those standards. Non-point source load reduction actions are implemented through a wide variety of programs at the state, local and federal level. These programs may be regulatory, non-regulatory or incentive-based e.g., a cost-share program. In addition, waterbody restoration can be assisted by voluntary actions on the part of citizen and/or environmental groups.

The EPA also provides funding for water quality improvement through a number of programs. The EPA Section 319 program provides grant money to the states, tribes, and territories to fund specific projects aimed at reducing the nonpoint source pollution. This program addresses the need for greater federal leadership to help focus state and local nonpoint source efforts. Under Section 319 of the Clean Water Act, states, territories and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects. The EPA also offers communities low-cost financing for a wide range of water quality infrastructure projects through the Clean Water State Revolving Fund.

To address hypoxic water issues, the EPA has implemented a number of programs and initiatives, most prominently the establishment of the Hypoxia Task Force (HTF), a partnership of federal, state, and tribal agencies that work together to reduce hypoxia in the Gulf of America and improve water quality in the MRB. The HTF member states have developed nutrient reduction strategies that aim to meet the HTF goals, including reducing size of the zone by 2035.

The HTF members are USEPA (co-chair), USDA, DOI, USACE, NOAA, twelve states: Iowa (co-chair), Arkansas, Illinois, Indiana, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Ohio, Tennessee, and Wisconsin, and a tribal representative. Established in 1997, it collaboratively works towards nutrient reduction goals, with federal funding to help HTF states, tribes, and other partners support the 2008 action plan. This action plan affirmed six overarching principles; to encourage voluntary, incentive-based actions; utilize existing state and federal regulatory mechanisms; follow adaptive management; identify additional funding needs and sources during annual budget processes; identify barriers to market-based solutions; and to provide measurable outcomes. These goals are focused on reducing the size of the Gulf of America hypoxic zone to less than 5000 square miles by 2035 with an interim target of reducing nutrient loads to the Gulf of America by 20% by 2025 and to increase the quality of life of communities within the MARB, especially those relying on agriculture, fisheries, and recreation sectors.

With the help of EPA funding, states and tribes have adopted a variety of remedial actions and programs to fight hypoxia. Among these are state cost share programs to advance conservation implementation, nutrient credit trading programs, implementation of TMDLs, and long-term monitoring programs. Monitoring programs already in place show a decline in total nitrogen from the MARB to the Gulf.

The EPA's Office of Pesticide Programs (OPP) further contributes to the EPA's mission of protecting human health and the environment through regulation of pesticides. OPP regulates the sale, distribution, and use of pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)[33] and the Federal Food, Drug, and Cosmetic Act (FFDCA). Examples of pesticides include insecticides, herbicides, rodenticides, disinfectants, and sanitizers. The EPA considers pesticides to be conventional pesticides,[34] antimicrobial pesticides,[35] or

[33] 7 U.S.C. § 136 *et seq.*
[34] Conventional active ingredients are generally produced synthetically (*i.e.*, synthetic chemicals that prevent, mitigate, destroy, or repel a pest or that act as a plant growth regulator, desiccant, defoliant, or nitrogen stabilizer).
[35] Antimicrobial pesticides are intended to disinfect, sanitize, reduce, or mitigate growth or development of microbiological organisms or protect inanimate objects, industrial processes or systems, surfaces, water, or other chemical substances from contamination, fouling, or deterioration caused by bacteria, viruses, fungi, protozoa, algae, or slime.

biopesticides.[36] Under FIFRA, the EPA shall register a pesticide if the EPA determines that, among other things, the pesticide will not generally cause unreasonable adverse effects on the environment when used in accordance with widespread and commonly recognized practice.[37] Pesticide actions subject to EPA review include new pesticidal active ingredients, new pesticide products containing previously registered active ingredients, amendments adding new uses for currently registered pesticides, among others. The EPA also must reevaluate existing pesticide registrations every 15 years as part of the registration review process under FIFRA.

In addition to the EPA's obligations under FIFRA and FFDCA, the Agency has an obligation under ESA to ensure that its pesticide actions are not likely to jeopardize the continued existence of federally threatened or endangered (or "listed") species or result in the destruction or adverse modification of designated critical habitats (collectively referred to as J/AM). The EPA consults with the Fish and Wildlife Service and National Marine Fisheries Service (collectively referred to as the Services) where necessary when a pesticide action "may affect" an individual of a listed species.

When the EPA evaluates the potential for a pesticide to impact the environment, including listed species, EPA begins by considering the existing or proposed pesticide uses; the use patterns, including application rates, protected crops and target pests, application methods; the environmental fate of the pesticide, such as major transport routes off-field, chemical degradation information; likely exposures to the pesticide; and toxicity to different taxonomic groups of species (or surrogate species) and their habitats.

When evaluating federally listed species, the EPA also considers geospatial information regarding where species and pesticide uses may co-occur and characteristics about a species or its habitat that could influence susceptibility to pesticide exposure or effects. The EPA considers potential impacts to more than 1600 listed species as well as any designated critical habitat. To estimate the potential effects of a pesticide on listed species and critical habitats, the EPA uses established ecological assessment principles, information on species from the Services, environmental modeling, and available real-world data. Real-world data can include environmental monitoring, incident data describing observed or reported ecological effects, and pesticide usage information describing where and to what extent a pesticide may be used on a commodity.

The EPA's evaluations incorporate a large body of scientific information that may include registrant-submitted studies that are required to support registration decisions as well as available relevant scientific literature that describe the environmental fate, exposure, toxicity, or other information that may inform the EPA's evaluations. These evaluations inform registration

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[36] Biopesticides are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. Biopesticides fall into three major classifications: Biochemical, Microbial, and Plant-Incorporated Protectants.

[37] FIFRA defines the term "unreasonable adverse effects on the environment" to mean: "(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under section 408 of the Federal Food, Drug, and Cosmetic Act." More information on FIFRA is available at: https://www.epa.gov/laws-regulations/summary-federal-insecticide-fungicide-and-rodenticide-act

and registration review decision by evaluating potential population level impacts and identifying potential mitigations intended to avoid population level impacts if needed. Some examples of approaches EPA uses to protect listed species and other non-target organisms as part of its pesticide registration and re-evaluation processes are summarized below.

The EPA conducts a BE when it registers a new conventional active ingredient or re-registers a pesticide. In its BEs, the EPA makes effects determinations, which identifies species that may be affected if a pesticide is used according to the proposed label. The EPA also predicts the likelihood that the Services may determine that the action is likely to result in J/AM to a listed species or critical habitat.[38] The EPA uses many of the same assessment methods to make its J/AM predictions that the Services use when they conduct biological opinions. Where appropriate, the EPA may also work with the registrant/applicant to include mitigation on pesticide labeling to avoid any potential future J/AM determinations by the Services.

While preventing J/AM is the statutory obligation under the ESA, as previously noted, when the EPA determines that granting a pesticide permit application "may affect" a listed species or designated critical habitats, the EPA initiates consultation with the relevant Service(s). A "may affect" finding is a much lower impact threshold, measured on whether one individual in a species may be affected, whereas a J/AM prediction is a population-level determination that an action may affect the future existence of the listed species or critical habitat.

The EPA must also re-evaluate all registrations containing a particular active ingredient every 15 years—a process called "registration review." Since registration review considers all registrations associated with an active ingredient, which may have an extensive history, BEs and any necessary ESA consultations for registration review cases can be more complex. In cases where the EPA makes a "may affect" finding and must consult, the EPA then works with the Services, USDA, and pesticide registrants/applicants during consultation to identify mitigations that avoid jeopardy and minimize take of listed species.

To facilitate ESA consultation and protect listed species earlier in the regulatory process prior to formal consultation, the EPA developed strategies intended to minimize population level impacts to species for herbicides, insecticides, and rodenticides (e.g., Herbicide Strategy).[39] The strategies provide a framework for evaluating whether a pesticide is likely to impact populations of species and, if so, what mitigations could be incorporated as part of labeling to minimize the potential for population impacts. The EPA is beginning to utilize these strategies in its registration review processes and to inform its BEs that are conducted for new active ingredient registrations.

EPA may implement mitigations through its established regulatory processes before initiating or completing consultation with the Services. When identifying appropriate levels of

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[38] Referred to as "predicted likelihood of future J/AM" in the BEs. *See* 50 C.F.R. § 402.40(b)(1) (noting that EPA's effects determinations for FIFRA actions may include, *inter alia*, conclusions and information on whether "the FIFRA action is likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat").
[39] More information in EPA's strategies and endangered species program is available at https://www.epa.gov/endangered-species/about-endangered-species-protection-program

any necessary mitigation to reduce impacts on listed species, the EPA considers pesticide-specific (e.g., use, fate and toxicity) and species-specific information. In general, the EPA's mitigations involve minimization of pesticide exposures by reducing the potential for pesticides to be transported from treatment areas to off-field habitats. Examples of minimization include use of lower application rates, measures that reduce runoff flow from treated fields, and measures that intercept or reduce pesticide spray drift. In rarer cases, mitigations may involve "avoidance," or the prohibition of direct applications to specific areas inhabited by listed species that may be uniquely susceptible to certain pesticide exposures.

Using these approaches, the EPA aims to reduce pesticide exposures to listed species, if necessary, before the EPA initiates or completes formal consultation with the Services. This can expedite protections that may be needed to reduce potential impacts to listed and non-listed species. The EPA's multi-chemical approaches, communication, and education efforts are intended to streamline consultations and more quickly advance species recovery.

IX. Framework and Species\Critical Habitat Determinations

The goal of the analyses presented herein is to link the RFS Set 2 Rule (the action) to estimates of the potential increases in biofuel demand that may be a result of the action and the corresponding potential increases in biofuel feedstock crop production necessitating land use changes to meet that demand. By using the potential acreage impacts, we assessed the potential locations of land use changes and linked that to potential species impacts by examining the areas that may be affected (on a percentage basis) relative to the total area of each species' critical habitat and/or range. In Section VII we present the analyses related to land use changes, and in Section VIII we present information related to potential changes in water quality associated with any land changes at both the edge-of-field and downstream levels. This Section IX takes our analyses a step further by assessing the potential effects of the action as they relate to endpoints specifically relevant to species, such as PBFs and PCEs of critical habitat and other pertinent life history information, to make final species determinations for this BE.

As an initial matter, we describe our interpretation of the thresholds for the various determinations we are making in this action.

A. Framework for Species/Critical Habitat Determinations

Under the Services' implementing regulations, effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. In other words, if the agency fails to take the proposed action and the activity would still occur, there is no ‘‘but for’’ causation. Given the significant uncertainty associated with land use change impacts as a result of the Set 2 Rule, particularly the inability to know what, if any, parcels of land which will actually be converted as a result of the rule, it is correspondingly difficult to say, with certainty, whether the Set 2 rule may affect terrestrial listed species and critical habitat through this mechanism

The Set 2 Rule may promote some land conversion which may impact listed species or critical habitat. We therefore conclude that the Set 2 Rule may affect listed species or critical habitat. However, these effects are not likely to adversely affect listed species or critical habitat due to the limited nature of changes that may be attributable to the RFS Set 2 Rule.

As to species and critical habitat at risk of potential impacts of the Set 2 Rule as a result of water quality degradation, we determine that the Set 2 Rule may affect some listed species and critical habitat.. The RFS Set 2 Rule may result in localized increases in pesticide and fertilizer applications, and these increases may affect some listed species and critical habitat as they transport through runoff to progressively larger bodies of water. However, we anticipate that such effects are not likely to adversely affect species and critical habitat given the limited nature of any such increases in pesticide and fertilizer quantities in the endpoint bodies of water, and as shown in Section VIII, at the national scale fertilizer impacts have historically remained relatively stable even as biofuel crop production increased.

B. FWS Species and Critical Habitats

The 699 FWS species (759 populations total) found within our action area were grouped into 14 taxonomic groupings that are commonly used by the FWS (US FWS, n.d.-e). Species within each of these taxonomic groups can be assessed together as they typically share similar patterns of survival and reproduction (i.e., life histories) and critical habitat PBFs/PCEs.

Insects

Out of the 45 insect populations found within the action area (Table IX.B-1), 12 have critical habitat with associated PBFs. PBFs for listed insects may include natural plant communities and herbaceous, woody, and aquatic vegetation for refugia, resting, reproduction, and prey avoidance; wet-mesic, moist meadows river floodplain, depression wetlands or other aquatic or semi-aquatic environments for refugia and shelter, reproduction, and prey avoidance; specific soil types, such as loam, sandy loam, loamy sand, gravel, organic soils, other types of soils conducive to larval survival and specific vegetation; and specific host or nectar plants required for reproduction, feeding, and growth. Other insects, such as butterflies, may require dynamic habitats with trees and/or understory plants with a specific range of elevations, densities, and canopy cover.

It is well known that insects in general are vulnerable to pesticide exposure and toxicity effects. Additionally, insect species in the action area that have PBFs more closely associated with specific grassland habitats (e.g., the Poweshiek skipperling) may be more likely to be affected. However, this does not necessarily mean that PBFs will be affected; lands that were once used for pasture, hay, or were retired could serve as more ideal locations for conversion, and these lands are not likely to have essential PBFs. Due to this and due to the limited nature of changes attributable to the RFS Set 2 Rule, potential effects on listed insects (as well as critical habitat PBFs) are insignificant or discountable.

Table IX.B-1: The 45 FWS Insect Populations With Designated Range and/or Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Lange's metalmark butterfly	*Apodemia mormo langei*		Endangered
Range	Eastern regal fritillary	*Argynnis idalia idalia*		Proposed Endangered
Range	Western regal fritillary	*Argynnis idalia occidentalis*		Proposed Threatened
Range	Coffin Cave mold beetle	*Batrisodes texanus*		Endangered
Range	Helotes mold beetle	*Batrisodes venyivi*		Endangered
Both	Rusty patched bumble bee	*Bombus affinis*		Endangered
Range	Franklin's bumble bee	*Bombus franklini*		Endangered
Range	Suckley's cuckoo bumble bee	*Bombus suckleyi*		Proposed Endangered
Range	Hungerford's crawling water Beetle	*Brychius hungerfordi*		Endangered
Range	San Bruno elfin butterfly	*Callophrys mossii bayensis*		Endangered
Both	Salt Creek Tiger beetle	*Cicindela nevadica lincolniana*		Endangered
Range	Ohlone tiger beetle	*Cicindela ohlone*		Endangered
Both	Monarch butterfly	*Danaus plexippus*		Proposed Threatened
Range	Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*		Threatened
Both	Delta green ground beetle	*Elaphrus viridis*		Threatened
Range	Puritan tiger beetle	*Ellipsoptera puritana*		Threatened
Range	Island marble Butterfly	*Euchloe ausonides insulanus*		Endangered
Range	Smith's blue butterfly	*Euphilotes enoptes smithi*		Endangered
Both	Taylor's (=whulge) Checkerspot	*Euphydryas editha taylori*		Endangered
Range	Northeastern beach tiger beetle	*Habroscelimorpha dorsalis dorsalis*		Threatened
Range	Bog buck moth	*Hemileuca maia menyanthevora (=H. iroquois)*		Endangered
Both	Dakota Skipper	*Hesperia dacotae*		Threatened
Both	Comal Springs riffle beetle	*Heterelmis comalensis*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Fender's blue butterfly	*Icaricia icarioides fenderi*		Threatened
Range	Mission blue butterfly	*Icaricia icarioides missionensis*		Endangered
Range	Lotis blue butterfly	*Lycaeides argyrognomon lotis*		Endangered
Range	Karner blue butterfly	*Lycaeides melissa samuelis*		Endangered
Range	Saint Francis' satyr butterfly	*Neonympha mitchellii francisci*		Endangered
Range	Mitchell's satyr Butterfly	*Neonympha mitchellii mitchellii*		Endangered
Range	American burying beetle	*Nicrophorus americanus*	Ex Pop, SW Missouri	Experimental Population, Non-Essential
Range	American burying beetle	*Nicrophorus americanus*	Wherever found, except where listed as an experimental population	Threatened
Both	Poweshiek skipperling	*Oarisma poweshiek*		Endangered
Range	Bethany Beach firefly	*Photuris bethaniensis*		Proposed Threatened
Range	Mount Hermon June beetle	*Polyphylla barbata*		Endangered
Both	[no common name] Beetle	*Rhadine exilis*		Endangered
Both	[no common name] Beetle	*Rhadine infernalis*		Endangered
Range	Tooth Cave ground beetle	*Rhadine persephone*		Endangered
Both	Hine's emerald dragonfly	*Somatochlora hineana*		Endangered
Range	Silverspot	*Speyeria nokomis nokomis*		Threatened
Range	Behren's silverspot butterfly	*Speyeria zerene behrensii*		Endangered
Range	Oregon silverspot butterfly	*Speyeria zerene hippolyta*		Threatened
Range	Myrtle's silverspot butterfly	*Speyeria zerene myrtleae*		Endangered
Both	Comal Springs dryopid beetle	*Stygoparnus comalensis*		Endangered
Range	Kretschmarr Cave mold beetle	*Texamaurops reddelli*		Endangered
Range	Zayante band-winged grasshopper	*Trimerotropis infantilis*		Endangered

Flowering Plants

The taxonomic group with the largest number of listed populations found within the action area is the flowering plants group. A total of 239 flowering plants were found within the action area (Table IX.B-2). Several species—including the Braun's rockcress, Fleshy-fruit gladecress and Navasota False Foxglove—saw some of the relatively higher cumulative impacts (Table VII.B-1) based on the potential land use change impact analyses.

Potential effects of the action that could harm flowering plants include, but are not limited to, effects on pollinators and seed dispersers, toxicity from pesticide exposure (e.g. herbicides), and loss of habitat. While some flowering plants may rely on abiotic pollination such as wind, others rely on biotic (e.g., insect or bat) pollination as their propagation strategy. The species that require biotic pollination may be indirectly affected if their pollinator populations are harmed by pesticide drift and/or habitat loss attributed to the RFS Set 2 Rule. This may occur near lands that are newly cultivated for agriculture, as well as near lands that apply higher amounts of pesticides to increase crop yields. While insecticide drift could harm some pollinators, it is unlikely that it would significantly reduce the population. It is possible that herbicide drift to a certain distance may harm listed plants. However, it is challenging to say with a high degree of confidence where potential effects of the RFS Set 2 Rule may occur at the local level, if at all. Converted fields are likely to be widely distributed across suitable farming land or in areas that are not suitable for listed species, even inf in a species' range, or areas that don't meet the definition of PBFs/PCEs. As such, the EPA anticipates that effects to pollinators would be insignificant or discountable.

Another potential effect is habitat loss. Many listed flowering plants rely on certain landscape features that are essential for their conservation. For example, the Short's Bladderpod relies on the following PBFs within its critical habitat: (1) bedrock formations and outcrops of calcareous limestone on steeply sloped hillsides near the mainstream and tributary areas of the Kentucky and Cumberland rivers; (2) well-drained soils that are undisturbed and shallow or rocky; (3) low-level canopy forest communities with some openings that provide sufficient sunlight (US FWS Region 3, n.d.). Other species, such as the Braun's rockcress, are also found in similar environments as discussed in Section VII.B. While it is possible that such areas could be affected by erosion exacerbated by agriculture, these or other nearby areas would very likely not be suitable for agriculture conversion and therefore not be affected.

Other species that rely on PBFs that are present in pasture and grassland ecosystems (or comparable ecosystems—e.g., the Fleshy-fruit gladecress' cedar glade habitat) may be more likely to have PBFs that are affected. But as discussed previously, new conversion of agricultural lands could occur in areas that are already not very suitable for PBFs. For instance, areas that were once used for pasture, hay, or retired croplands planted to permanent vegetative cover through the Conservation Reserve Program could be some of the lands that would be converted for agriculture. Such lands are not likely to have the essential PBFs that those species require. For this and the other reasons stated above, and because we cannot say for certain that effects will occur, any potential effects to flowering plants (as well as critical habitat PBFs) are likely discountable or insignificant.

Table IX.B-2: The 239 FWS Flowering Plant Populations With Designated Range and/or Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Large-fruited sand-verbena	*Abronia macrocarpa*		Endangered
Range	San Mateo thornmint	*Acanthomintha obovata ssp. duttonii*		Endangered
Both	White sturgeon	*Acipenser transmontanus*	U.S.A. (ID, MT), Kootenai R. system	Endangered
Range	Sensitive joint-vetch	*Aeschynomene virginica*		Threatened
Range	Sandplain gerardia	*Agalinis acuta*		Endangered
CH	Navasota False Foxglove	*Agalinis navasotensis*		Proposed Endangered
Range	Sonoma alopecurus	*Alopecurus aequalis var. sonomensis*		Endangered
Range	Seabeach amaranth	*Amaranthus pumilus*		Threatened
Range	South Texas ambrosia	*Ambrosia cheiranthifolia*		Endangered
Range	Little amphianthus	*Amphianthus pusillus*		Threatened
Range	Large-flowered fiddleneck	*Amsinckia grandiflora*		Endangered
Range	Price"s potato-bean	*Apios priceana*		Threatened
Both	Georgia rockcress	*Arabis georgiana*		Threatened
Both	Braun's rock-cress	*Arabis perstellata*		Endangered
Range	Dwarf Bear-poppy	*Arctomecon humilis*		Endangered
Both	Franciscan manzanita	*Arctostaphylos franciscana*		Endangered
Range	Presidio Manzanita	*Arctostaphylos hookeri var. ravenii*		Endangered
Range	Pallid manzanita	*Arctostaphylos pallida*		Threatened
Range	Marsh Sandwort	*Arenaria paludicola*		Endangered
Range	Sacramento prickly poppy	*Argemone pleiacantha ssp. pinnatisecta*		Endangered
Range	Mead's milkweed	*Asclepias meadii*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
CH	Prostrate milkweed	*Asclepias prostrata*		Endangered
Range	Welsh's milkweed	*Asclepias welshii*		Threatened
Range	Shivwits milk-vetch	*Astragalus ampullarioides*		Endangered
Range	Guthrie's (=Pyne's) ground-plum	*Astragalus bibullatus*		Endangered
Range	Sentry milk-vetch	*Astragalus cremnophylax var. cremnophylax*		Endangered
Both	Holmgren milk-vetch	*Astragalus holmgreniorum*		Endangered
Range	Mancos milk-vetch	*Astragalus humillimus*		Endangered
Both	Peirson's milk-vetch	*Astragalus magdalenae var. peirsonii*		Threatened
Range	Jesup's milk-vetch	*Astragalus robbinsii var. jesupii*		Endangered
Range	Coastal dunes milk-vetch	*Astragalus tener var. titi*		Endangered
Range	Star cactus	*Astrophytum asterias*		Endangered
Range	Texas ayenia	*Ayenia limitaris*		Endangered
Range	Hairy rattleweed	*Baptisia arachnifera*		Endangered
Range	Virginia round-leaf birch	*Betula uber*		Threatened
Range	Sonoma sunshine	*Blennosperma bakeri*		Endangered
Range	Shale barren rock cress	*Boechera serotina*		Endangered
Range	Decurrent false aster	*Boltonia decurrens*		Threatened
Range	Texas poppy-mallow	*Callirhoe scabriuscula*		Endangered
Range	Tiburon mariposa lily	*Calochortus tiburonensis*		Threatened
Range	Small-anthered bittercress	*Cardamine micranthera*		Endangered
Both	Golden sedge	*Carex lutea*		Endangered
Range	Navajo sedge	*Carex specuicola*		Threatened
Range	Tiburon paintbrush	*Castilleja affinis ssp. neglecta*		Endangered
Both	Fleshy owl's-clover	*Castilleja campestris ssp. succulenta*		Threatened
Range	swale paintbrush	*Castilleja ornata*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	California jewelflower	*Caulanthus californicus*		Endangered
Range	Fragrant prickly-apple	*Cereus eriophorus var. fragrans*		Endangered
Both	Hoover's spurge	*Chamaesyce hooveri*		Threatened
Range	Pygmy fringe-tree	*Chionanthus pygmaeus*		Endangered
Range	Ben Lomond spineflower	*Chorizanthe pungens var. hartwegiana*		Endangered
Both	Monterey spineflower	*Chorizanthe pungens var. pungens*		Threatened
Range	Scotts Valley spineflower	*Chorizanthe robusta var. hartwegii*		Endangered
Both	Robust spineflower	*Chorizanthe robusta var. robusta*		Endangered
Range	Sonoma spineflower	*Chorizanthe valida*		Endangered
Range	Fountain thistle	*Cirsium fontinale var. fontinale*		Endangered
Range	Pitcher's thistle	*Cirsium pitcheri*		Threatened
Range	Sacramento Mountains thistle	*Cirsium vinaceum*		Threatened
Both	Wright's marsh thistle	*Cirsium wrightii*		Threatened
Range	Presidio clarkia	*Clarkia franciscana*		Endangered
Range	Springville clarkia	*Clarkia springvillensis*		Threatened
Range	Morefield''s Leather Flower	*Clematis morefieldii*		Endangered
Range	Alabama Leather Flower	*Clematis socialis*		Endangered
Range	Pigeon wings	*Clitoria fragrans*		Threatened
Range	Etonia rosemary	*Conradina etonia*		Endangered
Range	Apalachicola rosemary	*Conradina glabra*		Endangered
Range	Cumberland rosemary	*Conradina verticillata*		Threatened
Range	Salt marsh bird's-beak	*Cordylanthus maritimus ssp. maritimus*		Endangered
Both	Soft bird's-beak	*Cordylanthus mollis ssp. mollis*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Palmate-bracted bird's beak	*Cordylanthus palmatus*		Endangered
Range	Lee pincushion cactus	*Coryphantha sneedii var. leei*		Threatened
Range	Sneed pincushion cactus	*Coryphantha sneedii var. sneedii*		Endangered
Range	Okeechobee gourd	*Cucurbita okeechobeensis ssp. okeechobeensis*		Endangered
Range	Jones Cycladenia	*Cycladenia humilis var. jonesii*		Threatened
Range	Leafy prairie-clover	*Dalea foliosa*		Endangered
Range	Beautiful pawpaw	*Deeringothamnus pulchellus*		Endangered
Range	Rugel's pawpaw	*Deeringothamnus rugelii*		Endangered
Range	Baker's larkspur	*Delphinium bakeri*		Endangered
Range	Yellow larkspur	*Delphinium luteum*		Endangered
Range	Longspurred mint	*Dicerandra cornutissima*		Endangered
Range	Smooth coneflower	*Echinacea laevigata*		Threatened
Range	Kuenzler hedgehog cactus	*Echinocereus fendleri var. kuenzleri*		Threatened
Range	Black lace cactus	*Echinocereus reichenbachii var. albertii*		Endangered
Range	Acuña Cactus	*Echinomastus erectocentrus var. acunensis*		Endangered
Range	Kern mallow	*Eremalche kernensis*		Endangered
Both	Willamette daisy	*Erigeron decumbens*		Endangered
Both	Umtanum desert buckwheat	*Eriogonum codium*		Threatened
Range	Gypsum wild-buckwheat	*Eriogonum gypsophilum*		Threatened
Both	Clay-Loving wild buckwheat	*Eriogonum pelinophilum*		Endangered
Range	San Mateo woolly sunflower	*Eriophyllum latilobum*		Endangered
Range	Arizona eryngo	*Eryngium sparganophyllum*		Endangered
Both	Contra Costa wallflower	*Erysimum capitatum var. angustatum*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Menzies' wallflower	*Erysimum menziesii*		Endangered
Range	Ben Lomond wallflower	*Erysimum teretifolium*		Endangered
Range	Minnesota dwarf trout lily	*Erythronium propullans*		Endangered
Range	Telephus spurge	*Euphorbia telephioides*		Threatened
Range	Gentner's Fritillary	*Fritillaria gentneri*		Endangered
Range	No common name	*Geocarpon minimum*		Threatened
Range	Spreading avens	*Geum radiatum*		Endangered
Range	Monterey gilia	*Gilia tenuiflora ssp. arenaria*		Endangered
Range	Bartram's stonecrop	*Graptopetalum bartramii*		Threatened
Range	Showy stickseed	*Hackelia venusta*		Endangered
Range	Harper's beauty	*Harperocallis flava*		Endangered
Range	Todsen's pennyroyal	*Hedeoma todsenii*		Endangered
Range	Roan Mountain bluet	*Hedyotis purpurea var. montana*		Endangered
Range	Virginia sneezeweed	*Helenium virginicum*		Threatened
Both	Pecos (=puzzle, =paradox) sunflower	*Helianthus paradoxus*		Threatened
Range	Schweinitz's sunflower	*Helianthus schweinitzii*		Endangered
Both	Whorled Sunflower	*Helianthus verticillatus*		Endangered
Range	Swamp pink	*Helonias bullata*		Threatened
Range	Marin dwarf-flax	*Hesperolinon congestum*		Threatened
Range	Dwarf-flowered heartleaf	*Hexastylis naniflora*		Threatened
Range	Neches River rose-mallow	*Hibiscus dasycalyx*		Threatened
Range	Slender rush-pea	*Hoffmannseggia tenella*		Endangered
Range	Santa Cruz tarplant	*Holocarpha macradenia*		Threatened
Both	Mountain golden heather	*Hudsonia montana*		Threatened
Range	Lakeside daisy	*Hymenoxys herbacea*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Texas prairie dawn-flower	*Hymenoxys texana*		Endangered
Range	Peter's Mountain mallow	*Iliamna corei*		Endangered
Range	Holy Ghost ipomopsis	*Ipomopsis sancti-spiritus*		Endangered
Range	Dwarf lake iris	*Iris lacustris*		Threatened
Range	Small whorled pogonia	*Isotria medeoloides*		Threatened
Range	Burke's goldfields	*Lasthenia burkei*		Endangered
Both	Contra Costa goldfields	*Lasthenia conjugens*		Endangered
Range	Beach layia	*Layia carnosa*		Threatened
Both	Fleshy-fruit gladecress	*Leavenworthia crassa*		Endangered
Both	Kentucky glade cress	*Leavenworthia exigua laciniata*		Threatened
Range	Barneby ridge-cress	*Lepidium barnebyanum*		Endangered
Both	Slickspot peppergrass	*Lepidium papilliferum*		Threatened
Range	Prairie bush-clover	*Lespedeza leptostachya*		Threatened
Range	Lyrate bladderpod	*Lesquerella lyrata*		Threatened
Range	Spring Creek bladderpod	*Lesquerella perforata*		Endangered
Range	San Francisco lessingia	*Lessingia germanorum (=L.g. var. germanorum)*		Endangered
Range	Heller's blazingstar	*Liatris helleri*		Threatened
Range	Huachuca water-umbel	*Lilaeopsis schaffneriana var. recurva*		Endangered
Range	Western lily	*Lilium occidentale*		Endangered
Range	Butte County meadowfoam	*Limnanthes floccosa ssp. californica*		Endangered
Range	Pondberry	*Lindera melissifolia*		Endangered
Both	Kincaid's Lupine	*Lupinus sulphureus ssp. kincaidii*		Threatened
Range	Clover (Tidestrom"s) lupine	*Lupinus tidestromii*		Endangered
Range	Rough-leaved loosestrife	*Lysimachia asperulaefolia*		Endangered
Range	White birds-in-a-nest	*Macbridea alba*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Walker's manioc	*Manihot walkerae*		Endangered
Range	Mohr's Barbara's buttons	*Marshallia mohrii*		Threatened
Range	Michigan monkey-flower	*Mimulus michiganensis*		Endangered
Range	MacFarlane's four-o'clock	*Mirabilis macfarlanei*		Threatened
Range	San Joaquin wooly-threads	*Monolopia (=Lembertia) congdonii*		Endangered
Range	Spreading navarretia	*Navarretia fossalis*		Threatened
Both	Colusa grass	*Neostapfia colusana*		Threatened
Both	Antioch Dunes evening-primrose	*Oenothera deltoides ssp. howellii*		Endangered
Range	Bakersfield cactus	*Opuntia treleasei*		Endangered
Both	San Joaquin Valley Orcutt grass	*Orcuttia inaequalis*		Threatened
Both	Hairy Orcutt grass	*Orcuttia pilosa*		Endangered
Range	Slender Orcutt grass	*Orcuttia tenuis*		Threatened
Both	Sacramento Orcutt grass	*Orcuttia viscida*		Endangered
Range	Canby's dropwort	*Oxypolis canbyi*		Endangered
Range	Fassett's locoweed	*Oxytropis campestris var. chartacea*		Threatened
Range	Papery whitlow-wort	*Paronychia chartacea*		Threatened
Range	Siler pincushion cactus	*Pediocactus (=Echinocactus,=Utahia) sileri*		Threatened
Range	Brady pincushion cactus	*Pediocactus bradyi*		Endangered
Range	San Rafael cactus	*Pediocactus despainii*		Endangered
Range	Knowlton's cactus	*Pediocactus knowltonii*		Endangered
Both	Fickeisen plains cactus	*Pediocactus peeblesianus ssp. fickeiseniae*		Endangered
Range	Blowout penstemon	*Penstemon haydenii*		Endangered
Range	White-rayed pentachaeta	*Pentachaeta bellidiflora*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Yreka phlox	*Phlox hirsuta*		Endangered
Both	White Bluffs bladderpod	*Physaria douglasii ssp. tuplashensis*		Threatened
Range	Missouri bladderpod	*Physaria filiformis*		Threatened
Both	Short's bladderpod	*Physaria globosa*		Endangered
Both	Zapata bladderpod	*Physaria thamnophila*		Endangered
Range	Godfrey's butterwort	*Pinguicula ionantha*		Threatened
Both	Yadon's piperia	*Piperia yadonii*		Endangered
Range	Ruth's golden aster	*Pityopsis ruthii*		Endangered
Range	White fringeless orchid	*Platanthera integrilabia*		Threatened
Range	Eastern prairie fringed orchid	*Platanthera leucophaea*		Threatened
Range	Western prairie fringed Orchid	*Platanthera praeclara*		Threatened
Range	Lewton's polygala	*Polygala lewtonii*		Endangered
Range	Tiny polygala	*Polygala smallii*		Endangered
Range	Sandlace	*Polygonella myriophylla*		Endangered
Range	Scotts Valley Polygonum	*Polygonum hickmanii*		Endangered
Range	Hickman's potentilla	*Potentilla hickmanii*		Endangered
Range	Maguire primrose	*Primula maguirei*		Threatened
Range	Hartweg's golden sunburst	*Pseudobahia bahiifolia*		Endangered
Range	San Joaquin adobe sunburst	*Pseudobahia peirsonii*		Threatened
Range	Harperella	*Ptilimnium nodosum*		Endangered
Range	Arizona Cliffrose	*Purshia (=Cowania) subintegra*		Endangered
Range	Autumn Buttercup	*Ranunculus aestivalis (=acriformis)*		Endangered
Range	Leedy's roseroot	*Rhodiola integrifolia ssp. leedyi*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Chapman rhododendron	*Rhododendron chapmanii*		Endangered
Range	Michaux's sumac	*Rhus michauxii*		Endangered
Range	Knieskern's Beaked-rush	*Rhynchospora knieskernii*		Threatened
Range	Miccosukee gooseberry	*Ribes echinellum*		Threatened
Range	Bunched arrowhead	*Sagittaria fasciculata*		Endangered
Range	Kral's water-plantain	*Sagittaria secundifolia*		Threatened
Range	Green Pitcher Plant	*Sarracenia oreophila*		Endangered
Range	Alabama Canebrake Pitcher Plant	*Sarracenia rubra ssp. alabamensis*		Endangered
Range	Mountain sweet pitcher-plant	*Sarracenia rubra ssp. jonesii*		Endangered
Range	Clay reed-mustard	*Schoenocrambe argillacea*		Threatened
Range	Barneby reed-mustard	*Schoenocrambe barnebyi*		Endangered
Range	Shrubby reed-mustard	*Schoenocrambe suffrutescens*		Endangered
Range	American chaffseed	*Schwalbea americana*		Endangered
Range	Northeastern bulrush	*Scirpus ancistrochaetus*		Endangered
Range	Tobusch fishhook cactus	*Sclerocactus brevihamatus ssp. tobuschii*		Threatened
Range	Pariette cactus	*Sclerocactus brevispinus*		Threatened
Range	Colorado hookless Cactus	*Sclerocactus glaucus*		Threatened
Range	Mesa Verde cactus	*Sclerocactus mesae-verdae*		Threatened
Range	Uinta Basin hookless cactus	*Sclerocactus wetlandicus*		Threatened
Range	Florida skullcap	*Scutellaria floridana*		Threatened
Range	Large-flowered skullcap	*Scutellaria montana*		Threatened
Both	Ocmulgee skullcap	*Scutellaria ocmulgee*		Endangered
Range	Keck's Checker-mallow	*Sidalcea keckii*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Wenatchee Mountains checkermallow	*Sidalcea oregana var. calva*		Endangered
Range	Fringed campion	*Silene polypetala*		Endangered
Range	Spalding's Catchfly	*Silene spaldingii*		Threatened
Range	White irisette	*Sisyrinchium dichotomum*		Endangered
Range	Houghton's goldenrod	*Solidago houghtonii*		Threatened
Range	Short's goldenrod	*Solidago shortii*		Endangered
Range	Blue Ridge goldenrod	*Solidago spithamaea*		Threatened
Both	Gierisch mallow	*Sphaeralcea gierischii*		Endangered
Range	Gentian pinkroot	*Spigelia gentianoides*		Endangered
Range	Virginia spiraea	*Spiraea virginiana*		Threatened
Range	Ute ladies'-tresses	*Spiranthes diluvialis*		Threatened
Range	Navasota ladies-tresses	*Spiranthes parksii*		Endangered
Both	Bracted twistflower	*Streptanthus bracteatus*		Threatened
Range	Tiburon jewelflower	*Streptanthus niger*		Endangered
Range	California seablite	*Suaeda californica*		Endangered
Range	Cooley's meadowrue	*Thalictrum cooleyi*		Endangered
Range	Howell"s spectacular thelypody	*Thelypodium howellii ssp. spectabilis*		Threatened
Range	Ashy dogweed	*Thymophylla tephroleuca*		Endangered
Range	Last Chance townsendia	*Townsendia aprica*		Threatened
Range	Showy Indian clover	*Trifolium amoenum*		Endangered
Range	Monterey clover	*Trifolium trichocalyx*		Endangered
Range	Persistent trillium	*Trillium persistens*		Endangered
Range	Relict trillium	*Trillium reliquum*		Endangered
Both	Greene's tuctoria	*Tuctoria greenei*		Endangered
Both	Solano grass	*Tuctoria mucronata*		Endangered
Range	Carter's mustard	*Warea carteri*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Tennessee yellow-eyed grass	*Xyris tennesseensis*		Endangered
Both	Texas wild-rice	*Zizania texana*		Endangered

Fishes, Clams, and Crustaceans

We found 102 fishes, 137 clams, and 21 crustaceans in the action area (Tables IX.B-3 through 5). The Alabama cavefish, Devils River minnow, Chucky Madtom, Slenderclaw crayfish, Noel's Amphipod, False spike, and Guadalupe Orb were some species within these three taxonomic groups that saw the relatively larger percentage overlap results from the potential land use impact analyses (Table VII.B-1).

The PBFs for many fish include creeks and streams with low turbidity, well oxygenated and moderately clean water, and riffles, pools, and runs with differing substrates of gravel, pebble, sand, and silt. Other essential features may include riparian cover and cooler temperature of waters, an abundant source of food, absence of invasive species, geomorphologically stable river channels and banks, and sufficient water depth (US FWS, 2018).

Clams have very similar PBFs but also rely on the occurrence of certain fish assemblages and community compositions. For many clams, like the Neosho mucket, the presence of specific fish hosts is also necessary. In the case of the Neosho mucket, hosts include smallmouth bass, largemouth bass, and spotted bass (US FWS Region 3, n.d.).

Finally, crustaceans have similar PBFs as well; many require small rocks or shallow burrows in gravel for shelter in small to medium flowing streams with boulder and pebble substrates. For the fish, clam, and crustacean taxonomic groups combined, the RFS Set 2 Rule could alter habitats and their essential features by contributing to water quality impairments. Species could also be exposed to pesticide runoff. However, the EPA anticipates that potential effects of the RFS Set 2 Rule would be insignificant or discountable for fish, clam, and crustacean populations as well as their critical habitats due to the uncertainties associated with the location of potential localized effects and due to the limited nature of changes that may be attributable to the RFS Set 2 Rule.

Table IX.B-3: The 102 FWS Fish Populations With Designated Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Shortnose sturgeon	*Acipenser brevirostrum*		Endangered
Both	Gulf sturgeon	*Acipenser oxyrinchus (=oxyrhynchus) desotoi*		Threatened
Range	Ozark cavefish	*Amblyopsis rosae*		Threatened
Range	Shortnose Sucker	*Chasmistes brevirostris*		Endangered
Both	June sucker	*Chasmistes liorus*		Threatened
Both	Laurel dace	*Chrosomus saylori*		Endangered
Range	Pygmy Sculpin	*Cottus paulus (=pygmaeus)*		Threatened
Range	Grotto Sculpin	*Cottus specus*		Endangered
Both	Diamond Darter	*Crystallaria cincotta*		Endangered
Range	Blue shiner	*Cyprinella caerulea*		Threatened
Range	Desert pupfish	*Cyprinodon macularius*		Endangered
Both	Pecos pupfish	*Cyprinodon pecosensis*		Proposed Threatened
Range	Lost River sucker	*Deltistes luxatus*		Endangered
Both	Devils River minnow	*Dionda diaboli*		Threatened
Both	Spring pygmy sunfish	*Elassoma alabamae*		Threatened
Range	Spotfin Chub	*Erimonax monachus*	U.S.A. (AL, TN-specified portions of Shoal Creek	Experimental Population, Non-Essential
Range	Spotfin Chub	*Erimonax monachus*	U.S.A. (TN-specified portions of the French Broad and Holston Rivers	Experimental Population, Non-Essential
Range	Spotfin Chub	*Erimonax monachus*	U.S.A. (TN-specified portions of the Tellico River	Experimental Population, Non-Essential

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Spotfin Chub	*Erimonax monachus*	Wherever found, except where listed as an Experimental Population	Threatened
Range	Slender chub	*Erimystax cahni*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers; see 17.84(s)(1)(i))	Experimental Population, Non-Essential
Both	Slender chub	*Erimystax cahni*		Threatened
Range	bluemask darter	*Etheostoma akatulo*		Endangered
Both	Slackwater darter	*Etheostoma boschungi*		Threatened
Range	Vermilion darter	*Etheostoma chermocki*		Endangered
Range	Relict darter	*Etheostoma chienense*		Threatened
Range	Etowah darter	*Etheostoma etowahae*		Endangered
Both	Fountain darter	*Etheostoma fonticola*		Endangered
Range	Yellowcheek Darter	*Etheostoma moorei*		Endangered
Both	Niangua darter	*Etheostoma nianguae*		Threatened
Both	Candy darter	*Etheostoma osburni*		Endangered
Range	Duskytail darter	*Etheostoma percnurum*	Tellico River, TN	Experimental Population, Non-Essential
Range	Duskytail darter	*Etheostoma percnurum*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Duskytail darter	*Etheostoma percnurum*		Endangered
Both	Rush Darter	*Etheostoma phytophilum*		Endangered
Range	Bayou darter	*Etheostoma rubrum*		Threatened
Range	Cherokee darter	*Etheostoma scotti*		Threatened
Both	Maryland darter	*Etheostoma sellare*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Kentucky arrow darter	*Etheostoma spilotum*		Threatened
Both	Cumberland darter	*Etheostoma susanae*		Endangered
Both	Trispot darter	*Etheostoma trisella*		Threatened
Range	Boulder darter	*Etheostoma wapiti*	Shoal Creek	Experimental Population, Non-Essential
Range	Boulder darter	*Etheostoma wapiti*		Endangered
Both	Tidewater goby	*Eucyclogobius newberryi*		Endangered
Both	Barrens topminnow	*Fundulus julisia*		Endangered
Range	Pecos gambusia	*Gambusia nobilis*		Endangered
Both	Humpback chub	*Gila cypha*		Threatened
Both	Bonytail	*Gila elegans*		Endangered
Range	Gila chub	*Gila intermedia*		Endangered
Range	Chihuahua chub	*Gila nigrescens*		Threatened
Range	Yaqui chub	*Gila purpurea*		Endangered
Both	Virgin River Chub	*Gila seminuda (=robusta)*		Endangered
Both	Rio Grande Silvery Minnow	*Hybognathus amarus*	Wherever found, except where listed as an Experimental Population	Endangered
Both	Delta smelt	*Hypomesus transpacificus*		Threatened
Range	Yaqui catfish	*Ictalurus pricei*		Threatened
Both	Peppered chub	*Macrhybopsis tetranema*		Endangered
Both	Spikedace	*Meda fulgida*		Endangered
Both	Waccamaw silverside	*Menidia extensa*		Threatened
Range	Palezone shiner	*Notropis albizonatus*		Endangered
Both	Smalleye Shiner	*Notropis buccula*		Endangered
Range	Cahaba shiner	*Notropis cahabae*		Endangered

CH, Range, or Both	**Common Name**	**Scientific Name**	**DPS (if applicable)**	**Listing Status**
Both	Arkansas River shiner	*Notropis girardi*	Arkansas River Basin (AR, KS, NM, OK, TX)	Threatened
Both	Cape Fear shiner	*Notropis mekistocholas*		Endangered
Both	Sharpnose Shiner	*Notropis oxyrhynchus*		Endangered
Both	Pecos bluntnose shiner	*Notropis simus pecosensis*		Threatened
Range	Topeka shiner	*Notropis topeka (=tristis)*	U.S.A. (MO-specified portions of Little Creek, Big Muddy Creek, and Spring Creek watersheds in Adair, Gentry, Harrison, Putnam, Sullivan, and Worth Counties)	Experimental Population, Non-Essential
Both	Topeka shiner	*Notropis topeka (=tristis)*	Wherever found, except where listed as an experimental population	Endangered
Range	Smoky madtom	*Noturus baileyi*	Tellico River, TN	Experimental Population, Non-Essential
Range	Smoky madtom	*Noturus baileyi*		Endangered
Both	Chucky Madtom	*Noturus crypticus*		Endangered
Range	Yellowfin madtom	*Noturus flavipinnis*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Yellowfin madtom	*Noturus flavipinnis*	U.S.A. (TN, VA-specified portions of the Holston River and watershed)	Experimental Population, Non-Essential

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Yellowfin madtom	*Noturus flavipinnis*	U.S.A. (TN-specified portions of the Tellico River)	Experimental Population, Non-Essential
Both	Yellowfin madtom	*Noturus flavipinnis*	Wherever found, except where listed as an experimental population	Threatened
Both	Carolina madtom	*Noturus furiosus*		Endangered
Both	Frecklebelly madtom	*Noturus munitus*	Upper Coosa River DPS	Threatened
Range	Neosho madtom	*Noturus placidus*		Threatened
Range	Pygmy madtom	*Noturus stanauli*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Lahontan cutthroat trout	*Oncorhynchus clarkii henshawi*		Threatened
Range	Greenback Cutthroat trout	*Oncorhynchus clarkii stomias*		Threatened
Range	Gila trout	*Oncorhynchus gilae*		Threatened
Both	Amber darter	*Percina antesella*		Endangered
Range	Goldline darter	*Percina aurolineata*		Threatened
Both	Pearl darter	*Percina aurora*		Threatened
Range	Coal darter	*Percina brevicauda*		Proposed Threatened
Both	Conasauga logperch	*Percina jenkinsi*		Endangered
Range	Leopard darter	*Percina pantherina*		Threatened
Range	Roanoke logperch	*Percina rex*		Endangered
Both	Sickle darter	*Percina williamsi*		Threatened
Range	Blackside dace	*Phoxinus cumberlandensis*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Woundfin	*Plagopterus argentissimus*	Gila R. drainage, AZ, NM	Experimental Population, Non-Essential
Both	Woundfin	*Plagopterus argentissimus*	Wherever found, except where listed as an experimental population	Endangered
Range	Gila topminnow (incl. Yaqui)	*Poeciliopsis occidentalis*		Endangered
Range	Mexican blindcat (catfish)	*Prietella phreatophila*		Endangered
Both	Colorado pikeminnow	*Ptychocheilus lucius*	Wherever found, except where listed as an Experimental Population	Endangered
Both	Atlantic salmon	*Salmo salar*	Gulf of Maine DPS	Endangered
Both	Bull Trout	*Salvelinus confluentus*	U.S.A., coterminous, lower 48 states	Threatened
Range	Pallid sturgeon	*Scaphirhynchus albus*		Endangered
Both	Alabama sturgeon	*Scaphirhynchus suttkusi*		Endangered
Both	Alabama cavefish	*Speoplatyrhinus poulsoni*		Endangered
Both	Longfin Smelt	*Spirinchus thaleichthys*	San Francisco Bay-Delta DPS	Endangered
Both	Loach minnow	*Tiaroga cobitis*		Endangered
Both	Razorback sucker	*Xyrauchen texanus*		Endangered

Table IX.B-4: The 137 FWS Clam Populations With Designated Range And/or Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Cumberland elktoe	*Alasmidonta atropurpurea*		Endangered
Range	Dwarf wedgemussel	*Alasmidonta heterodon*		Endangered
Both	Appalachian elktoe	*Alasmidonta raveneliana*		Endangered
Both	Southern elktoe	*Alasmidonta triangulata*		Proposed Endangered
Both	Fat threeridge (mussel)	*Amblema neislerii*		Endangered
Range	Ouachita rock pocketbook	*Arcidens wheeleri*		Endangered
Both	Spectaclecase (mussel)	*Cumberlandia monodonta*		Endangered
Both	Guadalupe Orb	*Cyclonaias necki*		Endangered
Both	Texas pimpleback	*Cyclonaias petrina*		Endangered
Both	Western fanshell	*Cyprogenia aberti*		Threatened
Both	Ouachita fanshell	*Cyprogenia sp. cf. aberti*		Threatened
Range	Fanshell	*Cyprogenia stegaria*	U.S.A. (TN - specified portions of the French Broad and Holston River)	Experimental Population, Non-Essential
Range	Fanshell	*Cyprogenia stegaria*		Endangered
Range	Dromedary pearlymussel	*Dromus dromas*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Dromedary pearlymussel	*Dromus dromas*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers	Experimental Population, Non-Essential
Range	Dromedary pearlymussel	*Dromus dromas*	Wherever found, except where listed as Experimental Populations	Endangered
Both	Chipola slabshell	*Elliptio chipolaensis*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Yellow lance	*Elliptio lanceolata*		Threatened
Both	Altamaha Spinymussel	*Elliptio spinosa*		Endangered
Both	Purple bankclimber (mussel)	*Elliptoideus sloatianus*		Threatened
Range	Cumberlandian combshell	*Epioblasma brevidens*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Cumberlandian combshell	*Epioblasma brevidens*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers	Experimental Population, Non-Essential
Both	Cumberlandian combshell	*Epioblasma brevidens*	Wherever found, except where listed as Experimental Populations	Endangered
Range	Oyster mussel	*Epioblasma capsaeformis*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Oyster mussel	*Epioblasma capsaeformis*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers	Experimental Population, Non-Essential
Both	Oyster mussel	*Epioblasma capsaeformis*	Wherever found, except where listed as Experimental Populations	Endangered
Range	Curtis Pearlymussel	*Epioblasma curtisii*		Endangered
Range	Tan riffleshell	*Epioblasma florentina walkeri (=E. walkeri)*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Purple Cat"s paw (=Purple Cat"s paw pearlymussel)	*Epioblasma obliquata*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Purple Cat's paw (=Purple Cat's paw pearlymussel)	*Epioblasma obliquata*		Endangered
Range	Southern combshell	*Epioblasma penita*		Endangered
Range	White catspaw (pearlymussel)	*Epioblasma perobliqua*		Endangered
Range	Northern riffleshell	*Epioblasma rangiana*		Endangered
Both	Snuffbox mussel	*Epioblasma triquetra*		Endangered
Both	Tapered pigtoe	*Fusconaia burkei*		Threatened
Range	Shiny pigtoe	*Fusconaia cor*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Shiny pigtoe	*Fusconaia cor*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Shiny pigtoe	*Fusconaia cor*	Wherever found, except where listed as Experimental Populations	Endangered
Range	Finerayed pigtoe	*Fusconaia cuneolus*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Finerayed pigtoe	*Fusconaia cuneolus*	U.S.A. (TN - specified portions of the French Broad and Holston River)	Experimental Population, Non-Essential
Range	Finerayed pigtoe	*Fusconaia cuneolus*	Wherever found, except where listed as Experimental Populations	Endangered
Both	Narrow pigtoe	*Fusconaia escambia*		Threatened
Both	Balcones spike	*Fusconaia iheringi*		Endangered
Both	Atlantic pigtoe	*Fusconaia masoni*		Threatened
Both	false spike	*Fusconaia mitchelli*		Endangered
Both	Longsolid	*Fusconaia subrotunda*		Threatened
Both	Finelined pocketbook	*Hamiota altilis*		Threatened
Both	Southern Sandshell	*Hamiota australis*		Threatened
Both	Orangenacre mucket	*Hamiota perovalis*		Threatened
Both	Shinyrayed pocketbook	*Hamiota subangulata*		Endangered
Range	Cracking pearlymussel	*Hemistena lata*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Cracking pearlymussel	*Hemistena lata*	U.S.A. (TN - specified portions of the French Broad and Holston River)	Experimental Population, Non-Essential
Range	Cracking pearlymussel	*Hemistena lata*	Wherever found, except where listed as Experimental Populations	Endangered
Range	Pink mucket (pearlymussel)	*Lampsilis abrupta*		Endangered
Range	Guadalupe Fatmucket	*Lampsilis bergmanni*		Endangered
Both	Texas fatmucket	*Lampsilis bracteata*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Higgins eye (pearlymussel)	*Lampsilis higginsii*		Endangered
Range	Arkansas fatmucket	*Lampsilis powellii*		Threatened
Both	Neosho Mucket	*Lampsilis rafinesqueana*		Endangered
Range	Speckled pocketbook	*Lampsilis streckeri*		Endangered
Range	Alabama lampmussel	*Lampsilis virescens*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Alabama lampmussel	*Lampsilis virescens*	Wherever found, except where listed as Experimental Populations	Endangered
Both	Carolina heelsplitter	*Lasmigona decorata*		Endangered
Both	Green floater	*Lasmigona subviridis*		Proposed Threatened
Range	Birdwing pearlymussel	*Lemiox rimosus*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert, and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Birdwing pearlymussel	*Lemiox rimosus*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Birdwing pearlymussel	*Lemiox rimosus*	Wherever found, except where listed as Experimental Populations	Endangered
Range	Scaleshell mussel	*Leptodea leptodon*		Endangered
Range	Louisiana pearlshell	*Margaritifera hembeli*		Threatened
Both	Alabama pearlshell	*Margaritifera marrianae*		Endangered
Both	Alabama moccasinshell	*Medionidus acutissimus*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Cumberland moccasinshell	*Medionidus conradicus*		Proposed Endangered
Both	Coosa moccasinshell	*Medionidus parvulus*		Endangered
Both	Gulf moccasinshell	*Medionidus penicillatus*		Endangered
Both	Ochlockonee moccasinshell	*Medionidus simpsonianus*		Endangered
Both	Suwannee moccasinshell	*Medionidus walkeri*		Threatened
Range	No common name	*Obovaria cf. unicolor*		Proposed Threatened
Both	Choctaw bean	*Obovaria choctawensis*		Endangered
Range	Ring Pink	*Obovaria retusa*	U.S.A. (TN - specified portions of the French Broad and Holston River)	Experimental Population, Non-Essential
Range	Ring Pink	*Obovaria retusa*		Endangered
Both	Round hickorynut	*Obovaria subrotunda*		Threatened
Range	Alabama hickorynut	*Obovaria unicolor*		Proposed Endangered
Range	James spinymussel	*Parvaspina collina*		Endangered
Range	Tar River spinymussel	*Parvaspina steinstansana*		Endangered
Range	Littlewing pearlymussel	*Pegias fabula*		Endangered
Range	White wartyback (pearlymussel)	*Plethobasus cicatricosus*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	White wartyback (pearlymussel)	*Plethobasus cicatricosus*		Endangered
Range	Orangefoot pimpleback (pearlymussel)	*Plethobasus cooperianus*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Orangefoot pimpleback (pearlymussel)	*Plethobasus cooperianus*		Endangered
Both	Sheepnose Mussel	*Plethobasus cyphyus*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Canoe Creek Clubshell	*Pleurobema athearni*		Endangered
Range	Clubshell	*Pleurobema clava*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Clubshell	*Pleurobema clava*	Wherever found, except where listed as Experimental Populations	Endangered
Range	Black clubshell	*Pleurobema curtum*		Endangered
Both	Southern clubshell	*Pleurobema decisum*		Endangered
Both	Dark pigtoe	*Pleurobema furvum*		Endangered
Both	Southern pigtoe	*Pleurobema georgianum*		Endangered
Both	Georgia pigtoe	*Pleurobema hanleyianum*		Endangered
Range	Tennessee clubshell	*Pleurobema oviforme*		Proposed Endangered
Both	Ovate clubshell	*Pleurobema perovatum*		Endangered
Range	Rough pigtoe	*Pleurobema plenum*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Rough pigtoe	*Pleurobema plenum*		Endangered
Both	Oval pigtoe	*Pleurobema pyriforme*		Endangered
Both	Louisiana Pigtoe	*Pleurobema riddellii*		Proposed Threatened
Both	Fuzzy pigtoe	*Pleurobema strodeanum*		Threatened
Range	Heavy pigtoe	*Pleurobema taitianum*		Endangered
Range	Tennessee pigtoe	*Pleuronaia barnesiana*		Proposed Endangered
Both	Slabside Pearlymussel	*Pleuronaia dolabelloides*		Endangered
Range	Cumberland pigtoe	*Pleuronaia gibber*		Endangered
Both	Texas Hornshell	*Popenaias popeii*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Texas heelsplitter	*Potamilus amphichaenus*		Proposed Endangered
Range	Fat pocketbook	*Potamilus capax*		Endangered
Range	Inflated heelsplitter	*Potamilus inflatus*		Threatened
Range	salina mucket	*Potamilus metnecktayi*		Proposed Endangered
Both	Triangular Kidneyshell	*Ptychobranchus greenii*		Endangered
Both	Southern kidneyshell	*Ptychobranchus jonesi*		Endangered
Both	Fluted kidneyshell	*Ptychobranchus subtentus*		Endangered
Both	Rabbitsfoot	*Quadrula cylindrica cylindrica*		Threatened
Both	Rough rabbitsfoot	*Quadrula cylindrica strigillata*		Endangered
Range	Winged Mapleleaf	*Quadrula fragosa*	U.S.A. (AL-specified portions of the Tennessee River; see 17.85(a)(1))	Experimental Population, Non-Essential
Range	Winged Mapleleaf	*Quadrula fragosa*	Wherever found, except where listed as an Experimental Population	Endangered
Both	Round Ebonyshell	*Reginaia rotulata*		Endangered
Both	Salamander mussel	*Simpsonaias ambigua*		Proposed Endangered
Range	Cumberland monkeyface (pearlymussel)	*Theliderma intermedia*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Cumberland monkeyface (pearlymussel)	*Theliderma intermedia*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Cumberland monkeyface (pearlymussel)	*Theliderma intermedia*	Wherever found, except where listed as Experimental Populations	Endangered
Range	Appalachian monkeyface (pearlymussel)	*Theliderma sparsa*	USA (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Appalachian monkeyface (pearlymussel)	*Theliderma sparsa*		Endangered
Range	Pale lilliput (pearlymussel)	*Toxolasma cylindrellus*		Endangered
Both	Mexican fawnsfoot	*Truncilla cognata*		Proposed Endangered
Both	Texas fawnsfoot	*Truncilla macrodon*		Threatened
Both	Rayed Bean	*Villosa fabalis*		Endangered
Above	Kentucky creekshell	*Villosa ortmanni*		Proposed Endangered
Both	Purple bean	*Villosa perpurpurea*		Endangered
Range	Cumberland bean (pearlymussel)	*Villosa trabalis*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Cumberland bean (pearlymussel)	*Villosa trabalis*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Cumberland bean (pearlymussel)	*Villosa trabalis*	Wherever found, except where listed as Experimental Populations	Endangered

Table IX.B-5: The 21 FWS Crustacean Species and Those With Designated Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	Listing Status
Range	Madison Cave isopod	*Antrolana lira*	Threatened
Both	Conservancy fairy shrimp	*Branchinecta conservatio*	Endangered
Both	Longhorn fairy shrimp	*Branchinecta longiantenna*	Endangered
Both	Vernal pool fairy shrimp	*Branchinecta lynchi*	Threatened
Range	Benton County cave crayfish	*Cambarus aculabrum*	Endangered
Range	Big Sandy crayfish	*Cambarus callainus*	Threatened
Both	Slenderclaw crayfish	*Cambarus cracens*	Endangered
Both	Brawleys Fork crayfish	*Cambarus williami*	Proposed Threatened
Range	Hell Creek Cave crayfish	*Cambarus zophonastes*	Endangered
Both	Big Creek Crayfish	*Faxonius peruncus*	Threatened
Both	St. Francis River Crayfish	*Faxonius quadruncus*	Threatened
Range	Illinois cave amphipod	*Gammarus acherondytes*	Endangered
Both	Noel's Amphipod	*Gammarus desperatus*	Endangered
Both	Vernal pool tadpole shrimp	*Lepidurus packardi*	Endangered
Range	Nashville crayfish	*Orconectes shoupi*	Endangered
Range	Squirrel Chimney Cave shrimp	*Palaemonetes cummingi*	Threatened
Range	Alabama cave shrimp	*Palaemonias alabamae*	Endangered
Both	Kentucky cave shrimp	*Palaemonias ganteri*	Endangered
Both	Black Creek crayfish	*Procambarus pictus*	Proposed Endangered
Both	Peck's cave amphipod	*Stygobromus (=Stygonectes) pecki*	Endangered
Range	Socorro isopod	*Thermosphaeroma thermophilus*	Endangered

Note: None of these species have separate DPSs.

Mammals

Fifty-eight mammals were found to be present in the action area (Table IX.B-6). Among the mammals, potential effects to most carnivores are very unlikely to occur. Many listed mammalian carnivores are nocturnal or crepuscular for most or part of the year and are also found within larger ranges. Depending on the species and its mobility, we anticipate that potential impacts would be discountable or insignificant as many carnivores are able to move to another region of their range if they experience some sort of localized disturbance. It is also unlikely that their prey base would be reduced to a degree that would harm the carnivorous species; again, they could move to another part of their range if there were any impacts to localized prey populations. Further, many carnivores such as the Canada lynx depend on certain types of vegetative cover such as dense understories and forests. As discussed previously, it is unlikely that forests would be converted to agriculture to meet biofuel demand attributable to the RFS Set 2 Rule.

For other types of mammals, such as rodents, bats, and ungulates, potential effects are also likely to be insignificant or discountable. Habitat types for many, but not all, of these species within these groups are unlikely to be affected by agriculture. Many ungulates, for example, are found in steep, high elevation, and rocky habitat; many squirrel and chipmunk populations occur in mature forest stands in protected areas; and bats are typically shelter in trees, under bark, or inside caves. Many of these mammal groups are also mobile and able to travel to other areas to forage if their food sources are impacted.

Other mammals may be more likely to be impacted by agricultural practices. For example, rodents that rely on more riparian areas (e.g., the New Mexico meadow jumping mouse) or grassland ecosystems for PBFs such as insects for food. As another example, the West Indian Manatee could be affected by water pollution from agricultural runoff. However, we anticipate that potential effects to these species would also be insignificant and discountable for the same reasons previously stated for flowering plants and other taxa (due to the limited nature and uncertainty of changes attributed to the RFS Set 2 Rule).

Table IX.B-6: The 58 FWS Mammal Populations With Designated Range and/or Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS or ESU (if applicable)	Listing Status
Range	Sonoran pronghorn	*Antilocapra americana sonoriensis*	U.S.A. (AZ), Mexico	Experimental Population, Non-Essential
Range	Sonoran pronghorn	*Antilocapra americana sonoriensis*	Wherever found, except where listed as an experimental population	Endangered
Range	Point Arena mountain beaver	*Aplodontia rufa nigra*		Endangered
Range	Pygmy Rabbit	*Brachylagus idahoensis*	Columbia Basin DPS	Endangered
Range	Gray wolf	*Canis lupus*	CO	Experimental Population, Non-Essential
Both	Gray wolf	*Canis lupus*	MN	Threatened
Range	Gray wolf	*Canis lupus*	U.S.A.: All of AL, AR, CA, CO, CT, DE, FL, GA, IA, IN, IL, KS, KY, LA, MA, MD, ME, MI, MO, MS, NC, ND, NE, NH, NJ, NV, NY, OH, OK, PA, RI, SC, SD, TN, TX, VA, VT, WI, and WV; and portions of AZ, NM, OR, UT, and WA. Mexico.	Endangered
Range	Mexican wolf	*Canis lupus baileyi*	U.S.A. (portions of AZ and NM)	Experimental Population, Non-Essential
Range	Mexican wolf	*Canis lupus baileyi*	Wherever found, except where listed as an experimental population	Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS or ESU (if applicable)	Listing Status
Range	Red wolf	*Canis rufus*	U.S.A. (portions of NC and TN)	Experimental Population, Non-Essential
Range	Red wolf	*Canis rufus*	Wherever found, except where listed as an experimental population	Endangered
Range	Ozark big-eared bat	*Corynorhinus (=Plecotus) townsendii ingens*		Endangered
Both	Virginia big-eared bat	*Corynorhinus (=Plecotus) townsendii virginianus*		Endangered
Range	Utah prairie dog	*Cynomys parvidens*		Threatened
Both	Texas kangaroo rat	*Dipodomys elator*		Proposed Endangered
Range	Giant kangaroo rat	*Dipodomys ingens*		Endangered
Both	Fresno kangaroo rat	*Dipodomys nitratoides exilis*		Endangered
Range	Tipton kangaroo rat	*Dipodomys nitratoides nitratoides*		Endangered
Range	Southern sea otter	*Enhydra lutris nereis*		Threatened
Both	Florida bonneted bat	*Eumops floridanus*		Endangered
Range	Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*		Endangered
Range	North American wolverine	*Gulo gulo luscus*		Threatened
Range	Ocelot	*Leopardus (=Felis) pardalis*		Endangered
Range	Mexican long-nosed bat	*Leptonycteris nivalis*		Endangered
Both	Canada Lynx	*Lynx canadensis*	Wherever found in contiguous U.S.	Threatened
Both	Pacific Marten, Coastal Distinct Population Segment	*Martes caurina*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS or ESU (if applicable)	Listing Status
Range	Florida salt marsh vole	*Microtus pennsylvanicus dukecampbelli*		Endangered
Range	Black-footed ferret	*Mustela nigripes*	U.S.A. (WY and specified portions of AZ, CO, MT, SD, and UT)	Experimental Population, Non-Essential
Range	Black-footed ferret	*Mustela nigripes*	Wherever found, except where listed as an experimental population	Endangered
Range	Gray bat	*Myotis grisescens*		Endangered
Range	Northern Long-Eared Bat	*Myotis septentrionalis*		Endangered
Both	Indiana bat	*Myotis sodalis*		Endangered
Range	Riparian woodrat (=San Joaquin Valley)	*Neotoma fuscipes riparia*		Endangered
Range	Columbian white-tailed deer	*Odocoileus virginianus leucurus*	Columbia River DPS	Threatened
Range	Peninsular bighorn sheep	*Ovis canadensis nelsoni*	Peninsular CA population	Endangered
Range	Jaguar	*Panthera onca*		Endangered
Range	Fisher	*Pekania pennanti*	Southern Sierra Nevada DPS	Endangered
Range	Tricolored bat	*Perimyotis subflavus*		Proposed Endangered
Both	Choctawhatchee beach mouse	*Peromyscus polionotus allophrys*		Endangered
Both	Alabama beach mouse	*Peromyscus polionotus ammobates*		Endangered
Range	Southeastern beach mouse	*Peromyscus polionotus niveiventris*		Threatened
Both	St. Andrew beach mouse	*Peromyscus polionotus peninsularis*		Endangered
Both	Perdido Key beach mouse	*Peromyscus polionotus trissyllepsis*		Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS or ESU (if applicable)	Listing Status
Range	Florida panther	*Puma (=Felis) concolor coryi*		Endangered
Range	Gulf Coast jaguarundi	*Puma yagouaroundi cacomitli*		Endangered
Range	Southern Mountain Caribou DPS	*Rangifer tarandus ssp. caribou*	Southern Mountain DPS	Endangered
Range	Salt marsh harvest mouse	*Reithrodontomys raviventris*		Endangered
Both	Buena Vista Lake ornate Shrew	*Sorex ornatus relictus*		Endangered
Range	Riparian brush rabbit	*Sylvilagus bachmani riparius*		Endangered
Range	Penasco least chipmunk	*Tamias minimus atristriatus*		Endangered
Both	Olympia pocket gopher	*Thomomys mazama pugetensis*		Threatened
Both	Tenino pocket gopher	*Thomomys mazama tumuli*		Threatened
Range	Yelm pocket gopher	*Thomomys mazama yelmensis*		Threatened
Both	West Indian Manatee	*Trichechus manatus*		Threatened
Range	Grizzly bear	*Ursus arctos horribilis*	U.S.A., conterminous (lower 48) States, except where listed as an Experimental Population	Threatened
Range	San Joaquin kit fox	*Vulpes macrotis mutica*		Endangered
Both	New Mexico meadow jumping mouse	*Zapus hudsonius luteus*		Endangered
Both	Preble's meadow jumping mouse	*Zapus hudsonius preblei*		Threatened

Birds

Among the 44 birds found within the action area (Table IX.B-7), the Streaked horned lark and the Piping plover were species that saw relatively higher potential impacts, with the Piping plover potentially impacted in both the percentage of critical habitat and the absolute number of acres (Tables VII.B-1). The Piping plover Great Lakes breeding population have PBFs that include shorelines and islands of the Great Lakes with sparsely vegetated and sandy landscapes dunes, and wetlands. This population also relies on the complex and dynamic ecology of the Great Lakes shoreline, which is in a constant change with natural disturbances from storms and sediment transportation (US FWS Region 3, n.d.).

The Northern Great Plains Piping plover population also depends on dynamic ecological processes and landscape features including permanently flooded wetlands, and sparsely vegetated sandbars, islands, and peninsulas on rivers, reservoirs, and inland lakes (US FWS Region 3, n.d.). These features could be potentially affected by erosion and runoff from agricultural fields. However, for reasons stated in IX.A, we anticipate discountable or insignificant effects.

This is the case for other listed birds as well. PBFs for many birds include access to forest and/or riparian areas with certain tree and understory species and diversity for roosting, nesting, and shelter. They also rely on such ecosystems for foraging of insects and other food sources. Birds typically have high mobility and are able to forage widely if they encounter localized threats or disturbances. As such, potential impacts from the RFS Rule, if any, are expected to be insignificant or discountable.

Table IX.B-7: The 44 FWS Bird Populations Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Florida grasshopper sparrow	*Ammodramus savannarum floridanus*		Endangered
Both	Mississippi sandhill crane	*Antigone canadensis pulla*		Endangered
Range	Florida scrub-jay	*Aphelocoma coerulescens*		Threatened
Both	Marbled Murrelet	*Brachyramphus marmoratus*	U.S.A. (CA, OR, WA)	Threatened
Both	rufa red knot	*Calidris canutus rufa*		Threatened
Range	Ivory-billed woodpecker	*Campephilus principalis*		Endangered
Range	Crested caracara (Audubon""s) [FL DPS]	*Caracara plancus audubonii*	FL DPS	Threatened
Both	Gunnison sage-grouse	*Centrocercus minimus*		Threatened
Both	Greater sage-grouse	*Centrocercus urophasianus*	Bi-State	Proposed Threatened
Both	Piping Plover	*Charadrius melodus*	[Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered.	Threatened
Both	Piping Plover	*Charadrius melodus*	[Great Lakes watershed DPS] - Great Lakes, watershed in States of IL, IN, MI, MN, NY, OH, PA, and WI	Endangered
Both	Western Snowy Plover	*Charadrius nivosus nivosus*	Pacific Coast population DPS-U.S.A. (CA, OR, WA)(within 50 miles of Pacific coast)	Threatened
Both	Yellow-billed Cuckoo	*Coccyzus americanus*	Western U.S. DPS	Threatened
Range	Red-cockaded woodpecker	*Dryobates borealis*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Southwestern willow flycatcher	*Empidonax traillii extimus*		Endangered
Both	Streaked Horned lark	*Eremophila alpestris strigata*		Threatened
Range	Northern Aplomado Falcon	*Falco femoralis septentrionalis*	U.S.A (AZ, NM)	Experimental Population, Non-Essential
Range	Northern Aplomado Falcon	*Falco femoralis septentrionalis*	Wherever found, except where listed as an Experimental Population	Endangered
Range	Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*		Threatened
Range	Whooping crane	*Grus americana*	U.S.A (Southwestern Louisiana)	Experimental Population, Non-Essential
Range	Whooping crane	*Grus americana*	U.S.A. (AL, AR, CO, FL, GA, ID, IL, IN, IA, KY, LA, MI, MN, MS, MO, NC, NM, OH, SC, TN, UT, VA, WI, WV, western half of WY)	Experimental Population, Non-Essential
Both	Whooping crane	*Grus americana*	Wherever found, except where listed as an Experimental Population	Endangered
Range	California condor	*Gymnogyps californianus*	Pacific Northwest NEP	Experimental Population, Non-Essential
Range	California condor	*Gymnogyps californianus*	U.S.A. (specific portions of Arizona, Nevada, and Utah)	Experimental Population, Non-Essential
Range	California condor	*Gymnogyps californianus*	Wherever found, except where listed as an Experimental Population	Endangered

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Mt. Rainier white-tailed ptarmigan	*Lagopus leucura rainierensis*		Threatened
Range	Eastern Black rail	*Laterallus jamaicensis ssp. jamaicensis*		Threatened
Range	Wood stork	*Mycteria americana*	AL, FL, GA, MS, NC, SC	Threatened
Range	Eskimo curlew	*Numenius borealis*		Endangered
Range	Short-tailed albatross	*Phoebastria (=Diomedea) albatrus*		Endangered
Range	Bermuda petrel	*Pterodroma cahow*		Endangered
Range	Black-capped Petrel	*Pterodroma hasitata*		Endangered
Range	Hawaiian petrel	*Pterodroma sandwichensis*		Endangered
Range	California Ridgway"s rail	*Rallus obsoletus obsoletus*		Endangered
Range	Yuma Ridgway's rail	*Rallus obsoletus yumanensis*		Endangered
Both	Everglade snail kite	*Rostrhamus sociabilis plumbeus*		Endangered
Range	golden-cheeked warbler	*Setophaga chrysoparia*		Endangered
Range	Roseate tern	*Sterna dougallii dougallii*	Northeast U.S. nesting population	Endangered
Range	California least tern	*Sternula antillarum browni*		Endangered
Both	Northern spotted owl	*Strix occidentalis caurina*		Threatened
Both	Mexican spotted owl	*Strix occidentalis lucida*		Threatened
Range	California Spotted Owl	*Strix occidentalis occidentalis*	Coastal-Southern California	Proposed Endangered
Range	Attwater's greater prairie-chicken	*Tympanuchus cupido attwateri*		Endangered
Range	Least Bell's vireo	*Vireo bellii pusillus*		Endangered

Snails

Twenty-nine snails were present in the action area for the RFS Set 2 Rule (Table IX.B-8). Snails are found on a variety of terrestrial and aquatic ecosystems. The PBFs for snails that live in aquatic environments are very similar to the PBFs for fish, clams, and crustaceans described previously (e.g., clean, well-oxygenated water with gravely beds and riffles). One with critical habitat found within the action area includes the Koster's springsnail which is found in New Mexico. The Roswell springsnail also has critical habitat in New Mexico, but in it lives in wetland sinkholes and spring-fed caves (US FWS, n.d.-i). It is unlikely that any effects of the RFS Rule would be detrimental to Roswell springsnail in particular because of where it lives. Nonetheless, EPA anticipates insignificant or discountable effects for all snails and their critical habitats due to the limited and uncertain nature of changes from the RFS Set 2 Rule.

Table IX.B-8: The 29 FWS Snail Populations and Those With Designated Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Painted snake coiled forest snail	*Anguispira picta*		Threatened
Both	Pecos assiminea snail	*Assiminea pecos*		Endangered
Range	Anthony's riversnail	*Athearnia anthonyi*	AL; Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL	Experimental Population, Non-Essential
Range	Anthony's riversnail	*Athearnia anthonyi*	U.S.A. (TN - specified portions of the French Broad and Holston Rivers)	Experimental Population, Non-Essential
Range	Anthony's riversnail	*Athearnia anthonyi*	Wherever found, except where listed as Experimental Populations	Endangered
Range	Slender campeloma	*Campeloma decampi*		Endangered
Range	Iowa Pleistocene snail	*Discus macclintocki*		Endangered
Range	Lacy elimia (snail)	*Elimia crenatella*		Threatened
Range	Banbury Springs limpet	*Idaholanx fresti*		Endangered
Both	Koster's springsnail	*Juturnia kosteri*		Endangered
Range	Round rocksnail	*Leptoxis ampla*		Threatened
Both	Interrupted (=Georgia) Rocksnail	*Leptoxis foremani*		Endangered
Range	Plicate rocksnail	*Leptoxis plicata*		Endangered
Range	Painted rocksnail	*Leptoxis taeniata*		Threatened
Range	Cylindrical lioplax (snail)	*Lioplax cyclostomaformis*		Endangered
Range	Royal marstonia (snail)	*Marstonia ogmorhaphe*		Endangered
Range	Armored snail	*Marstonia pachyta*		Endangered
Range	Chittenango ovate amber snail	*Novisuccinea chittenangoensis*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Snake River physa snail	*Physella natricina*		Endangered
Both	Magnificent ramshorn	*Planorbella magnifica*		Endangered
Both	Rough hornsnail	*Pleurocera foremani*		Endangered
Range	Virginia fringed mountain snail	*Polygyriscus virginianus*		Endangered
Range	Bruneau Hot springsnail	*Pyrgulopsis bruneauensis*		Endangered
Range	Chupadera springsnail	*Pyrgulopsis chupaderae*		Endangered
Range	Socorro springsnail	*Pyrgulopsis neomexicana*		Endangered
Both	Roswell springsnail	*Pyrgulopsis roswellensis*		Endangered
Range	Bliss Rapids snail	*Taylorconcha serpenticola*		Threatened
Range	Flat-spired three-toothed Snail	*Triodopsis platysayoides*		Threatened
Range	Tulotoma snail	*Tulotoma magnifica*		Threatened

Arachnids

Many of the 10 arachnids in the action area (Table IX.B-9) are spiders that occur in cave and forest habitats. It is not very likely that such areas would be affected by the RFS Set 2 Rule as they are areas that are not favorable for agriculture conversion. PBFs for arachnids may be particular to the caves or other environments in which they are found, but in general PBFs would be similar to those described under the insect section previously (e.g., vegetation and other features needed for refugia and foraging). As is the case with the insect taxonomic group, EPA anticipates discountable and insignificant effects for arachnids. Agriculture conversion or intensification caused by the Set 2 Rule, if any, would likely occur in areas that are already impacted and not suitable for habitat or in areas that meet criteria for arachnids' PBFs/PCEs.

Table IX.B-9: The 10 FWS Arachnid Populations and Those With Designated Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	Listing Status
Both	Robber Baron Cave Meshweaver	*Cicurina baronia*	Endangered
Both	Madla Cave Meshweaver	*Cicurina madla*	Endangered
Range	Government Canyon Bat Cave meshweaver	*Cicurina vespera*	Endangered
Range	Spruce-fir moss spider	*Microhexura montivaga*	Endangered
Range	Tooth Cave pseudoscorpion	*Tartarocreagris texana*	Endangered
Both	Government Canyon Bat Cave spider	*Tayshaneta microps*	Endangered
Range	Tooth Cave spider	*Tayshaneta myopica*	Endangered
Range	Cokendolpher Cave Harvestman	*Texella cokendolpheri*	Endangered
Range	Bee Creek Cave harvestman	*Texella reddelli*	Endangered
Range	Bone Cave harvestman	*Texella reyesi*	Endangered

Note: None of these species have separate DPSs.

Reptiles

Thirty-five reptiles were found within the action area (Table IX.B-10). Many reptiles can be found in a variety of habitats, including but not limited to forests, open fields, and near water. Some reptiles are fossorial and spend time underground, such as the Blunt-nose leopard lizard and Narrow-headed garter snake. Habitat for shelter and protection, hibernation, thermoregulation, foraging, and gestation are important, as is the absence of invasive species and access to prey and other food sources. Critical habitat PBFs may include woody debris and riparian vegetation, streams and ponds, and presence of small mammal burrows. It is possible that the Set 2 Rule may impact some of these features and habitats through conversion of lands and increases in sediment and pollution from agricultural runoff. EPA determines, however, that potential effects are discountable or insignificant because of the limited nature and uncertainty of changes especially at the local level.

Runoff from agriculture attributed to the Set 2 Rule may also affect other reptiles such as sea turtles that occur in marine and coastal regions. Some of these FWS marine reptiles are also managed by NMFS and, as discussed in Section V, EPA anticipates discountable and insignificant potential effects to these species. Further analyses in Section VIII affirm that potential effects in downstream areas would be limited relative to current conditions and therefore would not contribute to any measurable adverse effects.

Table IX.B-10: The 35 FWS Reptile Populations With Designated Range and/or Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS or ESU (if applicable)	Listing Status
Range	Northern wild monkshood	*Aconitum noveboracense*		Threatened
Range	Northwestern Pond Turtle	*Actinemys marmorata*		Proposed Threatened
Range	Southwestern pond turtle	*Actinemys pallida*		Proposed Threatened
Both	Loggerhead sea turtle	*Caretta caretta*	Northwest Atlantic Ocean DPS	Threatened
Range	Green sea turtle	*Chelonia mydas*	East Pacific DPS	Threatened
Both	Green sea turtle	*Chelonia mydas*	North Atlantic DPS	Threatened
Range	Leatherback sea turtle	*Dermochelys coriacea*		Endangered
Range	Eastern indigo snake	*Drymarchon couperi*		Threatened
Range	Hawksbill sea turtle	*Eretmochelys imbricata*		Endangered
Range	Blunt-nosed leopard lizard	*Gambelia silus*		Endangered
Range	bog turtle	*Glyptemys muhlenbergii*	Wherever found, except GA, NC, SC, TN, VA	Threatened
Both	Desert tortoise	*Gopherus agassizii*	Wherever found, except AZ south and east of Colorado R., and Mexico	Threatened
Range	Gopher tortoise	*Gopherus polyphemus*	Western DPS	Threatened
Range	Yellow-blotched map turtle	*Graptemys flavimaculata*		Threatened
Range	Ringed map turtle	*Graptemys oculifera*		Threatened
Range	Kemp's ridley sea turtle	*Lepidochelys kempii*		Endangered
Range	Olive ridley sea turtle	*Lepidochelys olivacea*	Wherever found, except when listed as endangered under 50 CFR 224.101	Threatened
Range	Suwannee alligator snapping turtle	*Macrochelys suwanniensis*		Threatened
Range	Alligator snapping turtle	*Macrochelys temminckii*		Proposed Threatened
Range	Alameda whipsnake (=striped racer)	*Masticophis lateralis euryxanthus*		Threatened
Range	Sand skink	*Neoseps reynoldsi*		Threatened
Range	Atlantic salt marsh snake	*Nerodia clarkii taeniata*		Threatened

Range	Copperbelly water snake	*Nerodia erythrogaster neglecta*	Indiana north of 40 degrees north latitude, Michigan, Ohio	Threatened
Both	Black pinesnake	*Pituophis melanoleucus lodingi*		Threatened
Both	Louisiana pinesnake	*Pituophis ruthveni*		Threatened
Both	Cedar Key mole skink	*Plestiodon egregius insularis*		Proposed Endangered
Range	Alabama red-bellied turtle	*Pseudemys alabamensis*		Endangered
Range	Plymouth Redbelly Turtle = Plymouth Redbelly Cooter	*Pseudemys rubriventris bangsi*		Endangered
Range	Dunes sagebrush lizard	*Sceloporus arenicolus*		Endangered
Range	Eastern Massasauga (=rattlesnake)	*Sistrurus catenatus*		Threatened
Range	Flattened musk turtle	*Sternotherus depressus*	Black Warrior R. system upstream from Bankhead Dam	Threatened
Both	Northern Mexican gartersnake	*Thamnophis eques megalops*		Threatened
Range	Giant garter snake	*Thamnophis gigas*		Threatened
Both	Narrow-headed gartersnake	*Thamnophis rufipunctatus*		Threatened
Range	San Francisco garter snake	*Thamnophis sirtalis tetrataenia*		Endangered

Amphibians

This BE identified 28 amphibians that may be impacted by the action (Table IX.B-11). As is the case for reptiles, many amphibians are fossorial and remain in underground burrows for long periods at a time. Others are semi or fully aquatic. Amphibians rely on food such as insects, crayfish, snails, and earthworms. Some essential features found in critical habitat may include the following: depressions in land that create ephemeral bodies of fresh water; tree and plant communities encompassing specific plant species or types; large shelter rocks in rivers and other habitat for refugia; wetlands with herbaceous vegetation. While it is possible that such features may be affected by agricultural conversion or runoff, EPA anticipates that potential effects would be discountable or insignificant for amphibians as well.

Table IX.B-11: The 28 FWS Amphibian Populations and Those With Designated Critical Habitat Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Both	Reticulated flatwoods salamander	*Ambystoma bishopi*		Endangered
Both	California tiger Salamander	*Ambystoma californiense*	U.S.A. (Central CA DPS)	Threatened
Range	Frosted Flatwoods salamander	*Ambystoma cingulatum*		Threatened
Range	Santa Cruz long-toed salamander	*Ambystoma macrodactylum croceum*		Endangered
Range	Dixie Valley Toad	*Anaxyrus williamsi*		Endangered
Both	Houston toad	*Bufo houstonensis*		Endangered
Range	Eastern Hellbender	*Cryptobranchus alleganiensis alleganiensis*	Missouri DPS	Endangered
Range	Eastern Hellbender	*Cryptobranchus alleganiensis alleganiensis*		Proposed Endangered
Range	Ozark Hellbender	*Cryptobranchus alleganiensis bishopi*		Endangered
Both	Salado Salamander	*Eurycea chisholmensis*		Threatened
Both	San Marcos salamander	*Eurycea nana*		Threatened
Both	Georgetown Salamander	*Eurycea naufragia*		Threatened
Range	Texas blind salamander	*Eurycea rathbuni*		Endangered
Range	Barton Springs salamander	*Eurycea sosorum*		Endangered
Both	Jollyville Plateau Salamander	*Eurycea tonkawae*		Threatened
Both	Austin blind Salamander	*Eurycea waterlooensis*		Endangered
Both	Black warrior (=Sipsey Fork) Waterdog	*Necturus alabamensis*		Endangered
Both	Neuse River waterdog	*Necturus lewisi*		Threatened

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status
Range	Red Hills salamander	*Phaeognathus hubrichti*		Threatened
Range	Cheat Mountain salamander	*Plethodon nettingi*		Threatened
Range	Shenandoah salamander	*Plethodon shenandoah*		Endangered
Range	Foothill yellow-legged frog	*Rana boylii*	Central Coast Distinct Population Segment (Central Coast DPS)	Threatened
Both	Foothill yellow-legged frog	*Rana boylii*	South Coast Distinct Population Segment (South Coast DPS)	Endangered
Range	Foothill yellow-legged frog	*Rana boylii*	South Sierra Distinct Population Segment (South Sierra DPS)	Endangered
Range	Chiricahua leopard frog	*Rana chiricahuensis*		Threatened
Both	California red-legged frog	*Rana draytonii*		Threatened
Both	Oregon spotted frog	*Rana pretiosa*		Threatened
Both	Dusky gopher frog	*Rana sevosa*		Endangered

Ferns and Allies; Conifers and Cycads; Lichens

Five ferns and allies, four conifers and cycads, and two lichens are present within the action area. The species within these three taxonomic groups are found within a variety of habitats, including forests of varying tree densities and species, ephemeral pools and aquatic ecosystems, vertical rock faces (in the case of the Rock Gnome lichen), and landscapes with particular soil types and/or moisture levels that are suitable for the species. Like flowering plants, some species rely on pollinators for reproduction. None of the species within the three groups have critical habitat. The EPA anticipates that potential effects would be discountable or insignificant.

Table IX.B-12: The 5 FWS Ferns and Allies Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	Listing Status
Range	American hart's-tongue fern	*Asplenium scolopendrium var. americanum*	Threatened
Range	Louisiana quillwort	*Isoetes louisianensis*	Endangered
Range	Black spored quillwort	*Isoetes melanospora*	Endangered
Range	Mat-forming quillwort	*Isoetes tegetiformans*	Endangered
Range	Alabama streak-sorus fern	*Thelypteris pilosa var. alabamensis*	Threatened

Note: None of these species have separate DPSs.

Table IX.B-13: The 4 FWS Conifers and Cycads Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	Listing Status
Range	Santa Cruz cypress	*Cupressus abramsiana*	Threatened
Range	Gowen cypress	*Cupressus goveniana ssp. goveniana*	Threatened
Range	Whitebark pine	*Pinus albicaulis*	Threatened
Range	Florida torreya	*Torreya taxifolia*	Endangered

Note: None of these species have separate DPSs.

Table IX.B-14: The 2 FWS Lichens Found Within the Action Area That Receive a NLAA Finding Due to Insignificant or Discountable Effects

CH, Range, or Both	Common Name	Scientific Name	Listing Status
Range	Florida perforate cladonia	*Cladonia perforata*	Endangered
Range	Rock gnome lichen	*Gymnoderma lineare*	Endangered

Note: Neither of these species have separate DPSs.

C. NMFS Species and Critical Habitats

Seventy-three NMFS populations were found in the action area. Out of the 73 populations, four are corals; 44 are fish; 14 are mammals; nine are reptiles; one is a snail; and one is an echinoderm (Table IX.C-1).

Table IX.C-1: The 73 NMFS Populations Found Within the Action Area and Their Associated Taxonomic Group

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status	Taxonomic Category
Both	Elkhorn coral	*Acropora palmata*		Threatened	Corals
Both	Lobed Star Coral	*Orbicella annularis*		Threatened	Corals
Both	Mountainous Star Coral	*Orbicella faveolata*		Threatened	Corals
Both	Boulder star coral	*Orbicella franksi*		Threatened	Corals
Range	Sunflower sea star	*Pycnopodia helianthoides*		Proposed Threatened	Echinoderms
Range	Shortnose sturgeon	*Acipenser brevirostrum*		Endangered	Fishes
Both	Green sturgeon	*Acipenser medirostris*	Southern	Threatened	Fishes
Both	Atlantic sturgeon (Gulf subspecies)	*Acipenser oxyrinchus (=oxyrhynchus) desotoi*		Threatened	Fishes
Both	Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Carolina	Endangered	Fishes
Both	Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Chesapeake Bay	Endangered	Fishes
Both	Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Gulf of Maine	Threatened	Fishes
Both	Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	New York Bight	Endangered	Fishes
Both	Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	South Atlantic	Endangered	Fishes
Range	Oceanic whitetip shark	*Carcharhinus longimanus*		Threatened	Fishes
Range	Giant manta ray	*Manta birostris*		Threatened	Fishes
Both	Coho salmon	*Oncorhynchus (=Salmo) kisutch*	Central California coast	Endangered	Fishes
Both	Coho salmon	*Oncorhynchus (=Salmo) kisutch*	Lower Columbia River	Threatened	Fishes
Both	Coho salmon	*Oncorhynchus (=Salmo) kisutch*	Oregon coast	Threatened	Fishes

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status	Taxonomic Category
Both	Coho salmon	*Oncorhynchus (=Salmo) kisutch*	Southern Oregon & Northern California coasts (SONCC)	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	California Central Valley	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Central California coast	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Lower Columbia River	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Middle Columbia River	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Northern California	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Puget Sound	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Snake River Basin	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	South-Central California coast	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Southern California	Endangered	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Upper Columbia River	Threatened	Fishes
Both	Steelhead	*Oncorhynchus (=Salmo) mykiss*	Upper Willamette River	Threatened	Fishes
Both	Sockeye salmon	*Oncorhynchus (=Salmo) nerka*	Ozette Lake	Threatened	Fishes
Both	Sockeye salmon	*Oncorhynchus (=Salmo) nerka*	Snake River	Endangered	Fishes
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	California coastal	Threatened	Fishes

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status	Taxonomic Category
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	Central Valley spring-run	Threatened	Fishes
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	Lower Columbia River	Threatened	Fishes
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	Puget Sound	Threatened	Fishes
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	Sacramento River winter-run	Endangered	Fishes
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	Snake River fall-run	Threatened	Fishes
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	Snake River spring/ summer-run	Threatened	Fishes
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	Upper Columbia River spring-run	Endangered	Fishes
Both	Chinook salmon	*Oncorhynchus (=Salmo) tshawytscha*	Upper Willamette River	Threatened	Fishes
Both	Chum salmon	*Oncorhynchus keta*	Columbia River	Threatened	Fishes
Both	Chum salmon	*Oncorhynchus keta*	Hood Canal summer-run	Threatened	Fishes
Range	Smalltooth sawfish	*Pristis pectinata*	U.S. portion of range	Endangered	Fishes
Both	Atlantic salmon	*Salmo salar*	Gulf of Maine	Endangered	Fishes
Both	Bocaccio	*Sebastes paucispinis*	Puget Sound/ Georgia Basin	Endangered	Fishes
Both	Yelloweye rockfish	*Sebastes ruberrimus*	Puget Sound/ Georgia Basin	Threatened	Fishes
Range	Scalloped Hammerhead Shark	*Sphyrna lewini*	Central & Southwest Atlantic	Threatened	Fishes
Both	Eulachon	*Thaleichthys pacificus*	Southern	Threatened	Fishes
Range	Guadalupe fur seal	*Arctocephalus townsendi*		Threatened	Mammals
Range	Sei whale	*Balaenoptera borealis*		Endangered	Mammals
Range	Blue whale	*Balaenoptera musculus*		Endangered	Mammals
Range	Finback whale	*Balaenoptera physalus*		Endangered	Mammals
Range	Rice's whale	*Balaenoptera ricei*		Endangered	Mammals

CH, Range, or Both	Common Name	Scientific Name	DPS (if applicable)	Listing Status	Taxonomic Category
Both	North Atlantic Right Whale	*Eubalaena glacialis*		Endangered	Mammals
Range	North Pacific Right Whale	*Eubalaena japonica*		Endangered	Mammals
Both	Steller sea lion	*Eumetopias jubatus*	Western	Endangered	Mammals
Both	Humpback whale	*Megaptera novaeangliae*	Central America	Endangered	Mammals
Both	Humpback whale	*Megaptera novaeangliae*	Mexico	Threatened	Mammals
Range	Humpback whale	*Megaptera novaeangliae*	Western North Pacific	Endangered	Mammals
Both	Killer whale	*Orcinus orca*	Southern Resident	Endangered	Mammals
Range	Sperm whale	*Physeter catodon (=macrocephalus)*		Endangered	Mammals
Range	False killer whale	*Pseudorca crassidens*	Main Hawaiian Islands Insular	Endangered	Mammals
Range	Loggerhead sea turtle	*Caretta caretta*	North Pacific Ocean	Endangered	Reptiles
Both	Loggerhead sea turtle	*Caretta caretta*	Northwest Atlantic Ocean	Endangered	Reptiles
Range	Green sea turtle	*Chelonia mydas*	East Pacific	Threatened	Reptiles
Range	Green sea turtle	*Chelonia mydas*	North Atlantic	Threatened	Reptiles
Both	Leatherback sea turtle	*Dermochelys coriacea*		Endangered	Reptiles
Range	Hawksbill sea turtle	*Eretmochelys imbricata*		Endangered	Reptiles
Range	Kemp's ridley sea turtle	*Lepidochelys kempii*		Endangered	Reptiles
Range	Olive ridley sea turtle	*Lepidochelys olivacea*	All other areas	Threatened	Reptiles
Range	Olive ridley sea turtle	*Lepidochelys olivacea*	Mexico's Pacific coast breeding colonies	Endangered	Reptiles
Both	Black Abalone	*Haliotis cracherodii*		Endangered	Snails

Another way to group species is by type of aquatic ecosystem(s) in which they reside. NMFS populations can be found in one or more of the following: offshore marine ecosystems, coastal ecosystems, and inland aquatic ecosystems (e.g., in the case of migratory salmonid species that spawn in headwaters of rivers and streams). As discussed in Section V of this BE, EPA concludes that potential effects would be insignificant or discountable for most of the offshore and/or coastal NMFS populations which include the following: Sei Whale, Rice's Whale , Blue Whale, Finback Whale, all listed Humpback Whale DPSs, Sperm Whale, the North Atlantic Right Whale, North Pacific Right Whale, False Killer Whale Main Hawaiian Islands Insular population), Olive Ridley Sea Turtle (Mexico's Pacific coast breeding colonies and all other areas populations), Leatherback Sea Turtle, Loggerhead Sea Turtle (Northwest Atlantic Ocean and North Pacific Ocean populations), Green Sea Turtle (North Atlantic and East Pacific populations), Hawksbill Sea Turtle, Kemp's Ridley Sea Turtle, Elkhorn Coral, Lobed Star Coral, Mountainous Star Coral, Boulder Star Coral, Steller Sea lion (Western population), Guadalupe Fur Seal, Oceanic Whitetip Shark, Scalloped Hammerhead Shark (Central & Southwest Atlantic population), and Giant Manta Ray. These species were not assessed in the potential land use impacts analyses described in Section VII. The Southern Resident Killer Whale was also not included in those analyses but must be considered separately as it depends on Chinook and other salmon populations that may be affected by the action. We discuss this in more detail in later paragraphs.

After making these conclusions for the above 30 populations, in Sections VII of this BE we evaluated the potential land use impacts that could occur within ranges and critical habitats of the remaining 43 NMFS populations. These assessments represented a variety of assumptions we made in attributing potential land use impacts to the RFS Set 2 Rule alone. In the same sections, we provided detailed information on many of these listed NMFS populations, including information on where they are found, what they are threatened by, and life history traits.

Forty-one of the 43 populations belong to the fish taxonomic group. The remaining two species are an echinoderm (Sunflower sea star) and a snail (Black Abalone). The mechanism through which the RFS Set 2 Rule may impact these species is through water quality effects from intensification and extensification of agriculture. Pesticide exposure can lead to toxicity effects in species and increases in nutrient and sediment deposition can alter their ecosystems and habitat as well as PBFs. PBFs for these aquatic species would be similar to the PBFs for FWS fish, clams, and crustaceans as discussed previously including clean and well-oxygenated water; creeks and streams with low turbidity and riffles, pools, and runs; riparian tree cover to provide shade and protect species from the heat; an abundant source of food and absence of invasive species; in addition to other essential physical, geomorphological, and biological features. Additionally, as discussed in the water quality section (Section VIII), potential concentrations of pollutants would be highest nearest to edge of field. While it is not feasible to determine the magnitude of localized pollutant concentrations associated with potential land use changes resulting from the RFS Set 2 Rule, it is important to assess the potential impacts on these populations which may occur in areas that are near or within watersheds where agricultural impacts could occur.

Recognizing that these NMFS populations are already exposed to pollution from existing cropland within their critical habitat and/or range, the EPA worked with NMFS for the 2023-

2025 RFS Set 1 BE on an additional analysis to better understand the potential effects. The following paragraphs and tables are an update of that same analysis to better understand the potential effects from the Set 2 Rule.

To complete this analysis, we first calculated the total area of corn, soy, and canola within species' range and critical habitat using the 2024 30-meter CDL and the following CDL codes: corn (code: 1), soybeans (5), and canola (31) in addition to all other CDL codes containing corn, soybeans, or canola, excluding sweet corn (12) and pop or orn corn (13), (CDL = 26, 225, 226, 228, 237, 239, 240, 241, 254). Then, using these numbers along with the conservative 95% percentile acreage increase results from the probabilistic analysis described in Section VII of this BE, we calculated the potential percent increase in cropland acres within species' critical habitat or range relative to existing corn, soy, and canola acreage numbers. It is important to note the assumptions in this analysis. One assumption is that the acreage increases from the probabilistic analysis would represent corn, soy, and canola cropland only, when in reality as discussed in previous sections they could represent other crops. Further, it is important to recognize that the baseline acreage numbers came from CDL data which does not always accurately capture land cover data. The overall accuracy for CDL cropland classification is around 90% for corn, for example (USDANASS, 2025).

The results of this additional analysis help to provide some understanding of potential impacts, but due to such assumptions and uncertainties they are used qualitatively. For example, to assess the extent to which the range of a species will see expansion of cropland. This informs how 1) the potential for an individual to be in close proximity to new cropland and 2) the potential magnitude of changes in pollutant concentrations at a larger scale (e.g. away from the converted cropland). Importantly, this qualitative analysis is very conservative in nature for a number of reasons, because for example we are using the 95% probabilistic result from an already conservative analysis. But, also, the percent increase in cropland is calculated relative to existing corn, soy, and canola cropland, when in reality a more accurate calculation would be to calculate it relative to the existing total cropland acreages within the range and critical habitat of a species.

The results from this additional analysis are shown in Tables IX.C-2 and 3. Table IX.C-2 shows the results for critical habitat without a buffer (S1 or scenario 1) and critical habitat with a buffer (S2). Scenario 2 is further shown in two results, including S2a where the buffer is included in the denominator for the calculations and S2b, where the buffer is not included. As explained in section VII.A, both approaches are reasonable but capture slightly different approaches to estimating impact. The percent using approach (a) may be interpreted as meaning the percent area in and around critical habitat affected by conversion in and around critical habitat. The percent using approach (b) is more conservative, as it may be interpreted as meaning the percent area *of critical habitat* affected by conversion in and around critical habitat.

The same was done for species' ranges. Table IX.C-3 shows the results based on the probabilistic analysis for range without a buffer (S3 or scenario 3) and with a buffer (S4), including S4a where the buffer is included in the denominator for the percent calculations and S4b, where the buffer is not included.

For critical habitat S1 (no buffer), the increase in percentage of cropland relative to the existing percent crop, corn, and canola acres in critical habitat ranged from 0 to 0.42 percent, with an average of 0.9 percent. For critical habitat S2a, the increase in percentage ranged from 0.001 to 0.31 percent, with an average of 0.11 percent. For critical habitat S2b, the increase in percentage ranged from 0.004 to 3.33 percent, with an average of 1.08 percent.

For range S3 (no buffer), the increase in percentage of cropland relative to the existing percent crop, corn, and canola acres in the range ranged from 0.001 to 0.28 percent, with an average of 0.09 percent. For range S4a, the increase in percentage ranged from 0.001 to 0.27 percent, with an average of 0.09 percent. For critical habitat S2b, the increase in percentage ranged from 0.002 to 0.29 percent, with an average of 0.101 percent.

Table IX.C-2: Critical Habitat Results From the Additional Qualitative Analysis[40]

Common Name	Population	Scientific Name	Total CH Acres	Total CH + Buffer Acres	Corn, Soy, and Canola Acres in CH	Corn, Soy, and Canola Acres in CH & buffer	Scenario 1 CH Acres Impacted (95th percentile)	Scenario 2 CH Acres Impacted (95th percentile)	Scenario 1 Percent Increase	Scenario 2a Percent Increase	Scenario 2b Percent Increase
Green Sturgeon	Southern	Acipenser medirostris	8216922	10091985	1859.67	32763.21	339	726.15	0.004	0.007	0.009
Atlantic sturgeon (Gulf subspecies)	None	Acipenser oxyrinchus (=oxyrhynchus) desotoi	1632075	2864439	21.35	2318.69	45	1053	0.003	0.037	0.065
Atlantic sturgeon	Carolina	Acipenser oxyrinchus oxyrinchus	67182	747117	243.08	31629.44	27.15	642	0.040	0.086	0.956
Atlantic sturgeon	Chesapeake Bay	Acipenser oxyrinchus oxyrinchus	31371	378246	90.51	25379.92	15	441	0.048	0.117	1.406
Atlantic sturgeon	Gulf of Maine	Acipenser oxyrinchus oxyrinchus	10380	127542	0.22	112.53	3	135	0.029	0.106	1.301
Atlantic sturgeon	New York Bight	Acipenser oxyrinchus oxyrinchus	18603	235308	0.00	846.88	6	189	0.032	0.080	1.016
Atlantic sturgeon	South Atlantic	Acipenser oxyrinchus oxyrinchus	98589	1014123	5.12	2137.88	54	1443.15	0.055	0.142	1.464
Chum salmon	Columbia River	Oncorhynchus keta	37878	380424	0.67	179.03	48	450.15	0.127	0.118	1.188
Chum salmon	Hood Canal summer-run	Oncorhynchus keta	103047	326181	1.33	2.00	36	159	0.035	0.049	0.154
Coho salmon	Lower Columbia River	Oncorhynchus (=Salmo) kisutch	176667	1730604	25.58	916.71	144	1254	0.082	0.072	0.710

[40] For each NMFS population critical habitat, the percent increase in crop acreage was calculated for scenario 1 (without a buffer) and scenarios 2a and 2b (with a buffer) based on total acres of critical habitat with or without a buffer, total acres of existing corn, soy, and canola cropland based on CDL data, and 95th percentile acreage impact results from the probabilistic analysis.

Coho salmon	Oregon coast	Oncorhynchus (=Salmo) kisutch	359931	3599142	88.29	1127.10	99	600	0.028	0.017	0.167
Steelhead	California Central Valley	Oncorhynchus (=Salmo) mykiss	126570	1400634	399.87	39607.85	93	747	0.073	0.053	0.590
Steelhead	Lower Columbia River	Oncorhynchus (=Salmo) mykiss	132390	1320675	0.00	631.82	60	660	0.045	0.050	0.499
Steelhead	Middle Columbia River	Oncorhynchus (=Salmo) mykiss	334992	3690198	574.00	14281.75	324.15	2919	0.097	0.079	0.871
Steelhead	Puget Sound	Oncorhynchus (=Salmo) mykiss	186207	1847145	1464.69	14115.85	468	2943.15	0.251	0.159	1.581
Steelhead	Snake River Basin	Oncorhynchus (=Salmo) mykiss	442362	4969659	142.78	7670.40	570	6495	0.129	0.131	1.468
Steelhead	Upper Columbia River	Oncorhynchus (=Salmo) mykiss	71214	809157	158.79	2581.56	111	1905	0.156	0.235	2.675
Steelhead	Upper Willamette River	Oncorhynchus (=Salmo) mykiss	70302	744183	201.93	5491.37	294	2340.15	0.418	0.314	3.329
Sockeye salmon	Snake River	Oncorhynchus (=Salmo) nerka	65943	725448	0.00	385.63	45	1263.3	0.068	0.174	1.916
Chinook salmon	Central Valley spring-run	Oncorhynchus (=Salmo) tshawytscha	63861	712431	97.85	10409.41	66	549	0.103	0.077	0.860
Chinook salmon	Lower Columbia River	Oncorhynchus (=Salmo) tshawytscha	71052	747339	0.00	519.96	60	582.15	0.084	0.078	0.819
Chinook salmon	Puget Sound	Oncorhynchus (=Salmo) tshawytscha	724557	2421414	585.79	12689.18	555	2505.15	0.077	0.103	0.346
Chinook salmon	Sacramento River winter-run	Oncorhynchus (=Salmo) tshawytscha	179241	418920	17.12	5513.39	24.15	198	0.013	0.047	0.110
Chinook salmon	Snake River fall-run	Oncorhynchus (=Salmo) tshawytscha	47523	576480	24.24	569.55	57	1524	0.120	0.264	3.207

Chinook salmon	Upper Columbia River spring-run	Oncorhynchus (=Salmo) tshawytscha	52617	600198	0.44	348.72	18	900.15	0.034	0.150	1.711
Chinook salmon	Upper Willamette River	Oncorhynchus (=Salmo) tshawytscha	80601	866355	132.32	4390.52	225.15	1992.15	0.279	0.230	2.472
Atlantic salmon	Gulf of Maine	Salmo salar	6154464	6812415	10665.39	11861.65	3087	3447	0.050	0.051	0.056
Bocaccio	Puget Sound/ Georgia Basin	Sebastes paucispinis	792015	1589076	1.11	7.34	30	225	0.004	0.014	0.028
Yelloweye Rockfish	Puget Sound/ Georgia Basin	Sebastes ruberrimus	353946	1063875	0.00	3.34	0	15	0.000	0.001	0.004
Eulachon	Southern	Thaleichthys pacificus	18438	225957	0.00	145.67	18	237	0.098	0.105	1.285

Table IX.C-3: Range Results From the Additional Qualitative Analysis[41]

Common Name	Population	Scientific Name	Total Range Acres	Total Range + Buffer Acres	Corn, Soy, and Canola Acres in Range	Corn, Soy, and Canola Acres in Range & buffer	Scenario 3 Range Acres Impacted (95th percentile)	Scenario 4 Range Acres Impacted (95th percentile)	Scenario 3 Percent Increase	Scenario 4a Percent Increase	Scenario 4b Percent Increase
Shortnose sturgeon	None	Acipenser brevirostrum	51310143	55205616	2170130	2347496	51279.15	56049.75	0.100	0.102	0.109
Green Sturgeon	Southern	Acipenser medirostris	18215073	20684565	91827	95088	6246.45	6750	0.034	0.033	0.037
Atlantic sturgeon (Gulf subspecies)	None	Acipenser oxyrinchus (=oxyrhynchus) desotoi	7481157	8077608	3244	4220	660	747.15	0.009	0.009	0.010
Atlantic sturgeon	Carolina	Acipenser oxyrinchus oxyrinchus	35009499	37521012	1853330	2040101	31851	34518	0.091	0.092	0.099
Atlantic sturgeon	Chesapeake Bay	Acipenser oxyrinchus oxyrinchus	31924443	34008921	1570700	1690027	26229.3	27918.15	0.082	0.082	0.087
Atlantic sturgeon	Gulf of Maine	Acipenser oxyrinchus oxyrinchus	26552295	28410585	1172535	1284471	17737.05	19023	0.067	0.067	0.072
Atlantic sturgeon	New York Bight	Acipenser oxyrinchus oxyrinchus	22743525	24271485	1223782	1342426	19395.3	20886.15	0.085	0.086	0.092
Atlantic sturgeon	South Atlantic	Acipenser oxyrinchus oxyrinchus	38548446	41408994	1463056	1606642	44754.75	48462.3	0.116	0.117	0.126
Chum salmon	Columbia River	Oncorhynchus keta	3043029	3305193	3853	4031	2367	2436	0.078	0.074	0.080
Chum salmon	Hood Canal summer-run	Oncorhynchus keta	683040	846957	2	2	324	345.15	0.047	0.041	0.051

[41] For each NMFS population range, the percent increase in crop acreage was calculated for scenario 3 (without a buffer) and scenarios 4a and 4b (with a buffer) based on total acres of range with or without a buffer, total acres of existing corn, soy, and canola cropland based on CDL data, and 95th percentile acreage impact results from the probabilistic analysis.

Coho salmon	Lower Columbia River	Oncorhynchus (=Salmo) kisutch	4601370	4909281	2944	2944	2406	2451	0.052	0.050	0.053
Coho salmon	Oregon coast	Oncorhynchus (=Salmo) kisutch	6424083	6779313	1269	1269	765	768.15	0.012	0.011	0.012
Coho salmon	Southern Oregon & Northern California coasts (SONCC)	Oncorhynchus (=Salmo) kisutch	11804553	12145254	468	468	483.15	483.15	0.004	0.004	0.004
Steelhead	California Central Valley	Oncorhynchus (=Salmo) mykiss	14739297	15332109	283619	288486	10755.6	10824.15	0.073	0.071	0.073
Steelhead	Central California coast	Oncorhynchus (=Salmo) mykiss	3825324	4019103	300	300	30	60	0.001	0.001	0.002
Steelhead	Lower Columbia River	Oncorhynchus (=Salmo) mykiss	4351974	4655031	2944	2944	2349	2418	0.054	0.052	0.056
Steelhead	Middle Columbia River	Oncorhynchus (=Salmo) mykiss	17048928	17926362	150625	159693	19473.15	20397.15	0.114	0.114	0.120
Steelhead	Puget Sound	Oncorhynchus (=Salmo) mykiss	6687237	7281570	21818	22283	5211.3	5421.3	0.078	0.074	0.081
Steelhead	Snake River Basin	Oncorhynchus (=Salmo) mykiss	20688429	21753399	140215	149309	26112	27120	0.126	0.125	0.131
Steelhead	Upper Columbia River	Oncorhynchus (=Salmo) mykiss	7388439	8229948	99930	111253	17346	19113.6	0.235	0.232	0.259
Steelhead	Upper Willamette River	Oncorhynchus (=Salmo) mykiss	4256319	4599828	15673	15963	11952.15	12273.15	0.281	0.267	0.288
Sockeye salmon	Snake River	Oncorhynchus (=Salmo) nerka	6520827	7389906	80498	88598	13131	14352.45	0.201	0.194	0.220
Chinook salmon	Central Valley spring-run	Oncorhynchus (=Salmo) tshawytscha	12581082	13210374	256660	261913	8391.15	8709	0.067	0.066	0.069

Chinook salmon	Lower Columbia River	Oncorhynchus (=Salmo) tshawytscha	4696911	5001405	2944	2944	2397	2448.3	0.051	0.049	0.052
Chinook salmon	Puget Sound	Oncorhynchus (=Salmo) tshawytscha	6921639	7774068	21887	22354	5505.15	5712	0.080	0.073	0.083
Chinook salmon	Sacramento River winter-run	Oncorhynchus (=Salmo) tshawytscha	3535053	3993042	50159	53689	2862	3027	0.081	0.076	0.086
Chinook salmon	Snake River fall-run	Oncorhynchus (=Salmo) tshawytscha	6333096	7117785	101446	112772	16896.45	18372.75	0.267	0.258	0.290
Chinook salmon	Snake River spring/ summer-run	Oncorhynchus (=Salmo) tshawytscha	16374774	17368197	92038	99501	19158.15	20190.15	0.117	0.116	0.123
Chinook salmon	Upper Columbia River spring-run	Oncorhynchus (=Salmo) tshawytscha	6828345	7575660	88282	98164	16383	18000.75	0.240	0.238	0.264
Chinook salmon	Upper Willamette River	Oncorhynchus (=Salmo) tshawytscha	5630055	6093042	14181	14595	11085.15	11868	0.197	0.195	0.211
Atlantic salmon	Gulf of Maine	Salmo salar	3265419	3560664	109	129	168	231.15	0.005	0.006	0.007
Smalltooth sawfish	U.S. portion of range	Pristis pectinata	12981909	14183274	752	1349	558	708.15	0.004	0.005	0.005
Sunflower sea star	None	Pychnopodia helianthoides	80821242	86033373	7537	8267	1911	2256	0.002	0.003	0.003
Bocaccio	Puget Sound/ Georgia Basin	Sebastes paucispinis	1545513	2255277	7303	7792	1794	2082	0.116	0.092	0.135
yelloweye rockfish	Puget Sound/ Georgia Basin	Sebastes ruberrimus	1545513	2255277	7303	7792	1782	2094	0.115	0.093	0.135
Eulachon	Southern	Thaleichthys pacificus	1561458	1937109	2911	2916	1548	1761.15	0.099	0.091	0.113

Overall, the numbers representing a potential increase in percentage of cropland relative to existing corn, soy, and canola acres are small. As such, the EPA anticipates that potential effects of the RFS Set 2 Rule on all these species are discountable. Since this list of species includes the salmon that the Southern resident killer whale depends on, we also conclude that the Southern resident killer whale would experience discountable effects in regard to prey availability and otherwise insignificant effects as described in Section V for some marine species that reside in coastal regions.

X. Conclusions

Based on the analyses presented in this BE, we find that the Renewable Fuel Standard (RFS) Program: Standards for 2026–2027 and Other Changes, or the "Set 2 Rule," is not likely to adversely affect listed species or critical habitat. The primary mechanism through which this rule is expected to impact listed species is through establishing volume requirements for the use of various types of renewable fuels, thus increasing demand for these renewable fuels. For non-crop-based biofuels, such as CNG/LNG derived from biogas and biodiesel and renewable diesel produced from waste fats, oils and greases, we determined there would be no effect on listed species and critical habitat. In addition, this action implements regulatory changes that will not impact the volumes of renewable fuel and will also not impact listed species or critical habitat because they are administrative in nature.

For crop-based biofuels such as corn ethanol, soybean biodiesel, and canola biodiesel, we determined that the increased consumption and production may affect listed species. Ultimately, the increase in demand for feedstocks used to produce renewable fuels could potentially lead to an increase in the amount of land used to produce these crops. Listed species could potentially be impacted by loss of PBFs in critical habitat or loss of range to cropland, or by water quality impacts from increased loads of fertilizers and pesticides. In this BE, we identified the action area where these impacts could occur and found that 821 unique populations may be impacted by the action.

However, our analyses conclude that impacts from the RFS Set 2 Rule, if any, would be insignificant and/or discountable. First and foremost, we reach this conclusion because of various uncertainties and complex causal chain of steps that occur in-between the EPA setting the RFS volume requirements to potential on-the-ground land use changes (Figure A-1 in Appendix A).

In this BE, we first projected the degree to which the Set 2 Rule might increase the consumption of renewable fuels in 2026–2027 relative to a scenario where there were no RFS volume requirements for these two years.[42] We assumed (conservatively) that the entire increase in renewable fuel consumption attributable to the Set 2 Rule would result in a corresponding increase in domestic biofuel production.

After projecting the potential increase in biofuel production, we next projected the potential impact of the increased demand for feedstocks used to produce these biofuels on crop production. Where possible, we relied upon the best available science and data (e.g., published literature or assessments completed in the context of other RFS actions) to inform our estimates.

The changes in land use potentially attributable to the Set 2 Rule, briefly described above and presented in more detail in Section VI, represent our best estimates using the available data. There is, however, a considerable degree of uncertainty associated with these estimates. For example, there is uncertainty associated with estimating the volume biofuel consumption that can

[42] While the analysis was initially performed based on the proposed applicable volumes, for the reasons described in Section IV.A.2, the analysis represents a conservative approach to projecting the impacts of the attributable volumes in the final rule, as the land use change projections based on the attributable volumes in the final rule are lower than the land used change projections based on the attributable volumes in the proposed rule .

be attributed to the RFS program generally, and to the Set 2 Rule in particular. We cannot predict with certainty which biofuels will be used to meet the broad RFS volume requirements in 2026–2027, and it is even more difficult to project the quantity of these fuels that would be used in the absence of the RFS program. The use of compliance flexibilities under the RFS program, in particular carryover RINs and deficit carryovers, also introduce uncertainty into the volume of renewable fuel that will be consumed in the future.

There is also considerable uncertainty in the relationship between biofuel consumption and biofuel production in the U.S. The RFS program is designed to ensure a minimum volume of biofuel consumption, but it does not directly regulate domestic biofuel production or limit it to U.S. production. For example, ethanol producers can, and typically do, produce higher volumes than can be consumed domestically, with the excess ethanol being exported. While we have estimated the volume of biofuel consumption that can potentially be attributed to the Set 2 Rule, it is considerably more difficult to determine how this volume of biofuel consumption influences domestic biofuel production since an increase in biofuel consumption can also be met with a decrease in biofuel exports and/or an increase in biofuel imports. For the purposes of our analyses, we have made the conservative assumption that every gallon of biofuel consumption attributable to the Set 2 Rule corresponds to one gallon of additional domestic production of biofuel, but in fact the actual impact on biofuel production is likely to be smaller, and could in fact be zero, as the market adjusts import and export volumes in response to changes in domestic biofuel demand.

A similar dynamic is at play in the relationship between domestic biofuel production and domestic production of the crops used to produce biofuels, adding even more uncertainty to the analyses. The corn, soybean oil, and canola oil used to produce the volumes of renewable fuel that we estimate are potentially attributable to the Set 2 Rule can come from several sources. If the necessary feedstocks result in increased corn, soybean, and canola plantings, this could have direct implications for listed species or critical habitat. However, the necessary feedstocks could also derive from a reduction in exports or a diversion of these feedstocks away from food and feed markets. In both cases, there may be no change in crop plantings and thus no direct impact on species or habitat, though there might still be some indirect effects on total cropland as markets shift to accommodate the change in the use of these feedstocks.

In general, we have made conservative assumptions in our projection of the amount of land use change potentially attributable to the Set 2 Rule (e.g., assumptions that would lead to higher projections of land use change). We believe this is appropriate in the context of this BE, as we consider the potential impacts of this rule on listed species. However, we note that the consistent use of these conservative assumptions in the many steps of this analysis compound on each other to likely result in an over-projection of land use change potentially attributable to the Set 2 Rule.

In order to assess the potential impacts on listed species and critical habitat, it is important to know geographically where land use changes from the RFS Set 2 Rule, if any, could occur. Land use changes can contribute to species' exposure to pollution from nutrient, sediment, and pesticide runoff. However, any potential land use changes from the Set 2 Rule would occur at a very small scale and local level across a very large geographical area that represents available land for conversion within the action area. As there are many factors that drive agricultural growth, the location of such changes attributable to the RFS Set 2 Rule alone is very challenging to assess and determine with any certainty.

Nevertheless, we attempted to identify potential locations of land use changes. To assess corn ethanol and soy biodiesel we analyzed estimated land change acreage using published literature analyzing direct and indirect effects. We then utilized the same probabilistic approach from our Set 1 BE. This selected lands available for conversion within the action area and repeated the process 100 to 500 times to generate an estimated probability that any given acrea of land would be converted. For canola biodiesel we used existing EPA modeling in order to estimate potential land use changes. This result was used in the same probabilistic model described above.

In no particular order, the following FWS species were found to experience higher potential acreage impacts to their critical habitat and/or range relative to all other species: the Salt Creek Tiger beetle, Umtanum desert buckwheat, Poweshiek skipperling, Dakota Skipper, Clay-Loving wild buckwheat, Brawleys Fork crayfish, Topeka shiner, Amber darter, Fleshy-fruit gladecress, Slenderclaw crayfish, Devils River minnow, Slackwater darter, Bliss Rapids snail, False spike, Pariette cactus, Madison Cave isopod, Chucky madtom, White catspaw, Neosho mucket, Howell's spectacular thelypody and Virginia round-leaf birch.

For FWS species we found that 16 species could potentially have greater than 1 percent of their critical habitat directly converted to cropland and 11 species would have greater than 1 percent of their range directly converted. For the scenarios with a 2,600-foot buffer, we calculated the potential impact in two manners. The number of FWS species with greater than 1 percent impact was much greater under the S2b and S4b scenarios for critical habitat and range, respectively, which used a more conservative approach of not including the area of the buffer in the denominator for calculations (Table VII.B-1). For NMFS species, zero populations saw greater than 1 percent impacts directly to their critical habitat or range, as seen in Scenarios 1 and 3. Only the S2b scenario saw potential impacts of 1 percent or greater, which included potential impacts to Chinook Salmon populations, Atlantic Sturgeon populations, Steelhead populations, and the Eulachon.

Additionally, we considered essential PBFs/PCEs of critical habitat and species taxa information such as feeding, survival, and reproduction needs and strategies in Section IX. In the case of the Salt Creek Tiger beetle's critical habitat as an example, the species is found in a very small area (1,100 acres) north of Lincoln, Nebraska. It includes saline wetlands and streams that are fed by groundwater discharge originating from Pennsylvanian and/or Permian formations as it passes through a salt source (*79 FR 26014*, 2014). Although this area is classified as available land in our analyses, we cannot determine with reasonable certainty that agricultural growth attributable to the Set 2 Rule would occur in or near this critical habitat. First, the saline environment may not be favorable for agriculture. Further, there are many other factors, beyond the RFS program, that influence biofuel production and land use change. Therefore, it is possible that the RFS Set 2 Rule alone won't contribute to any future land use or water quality changes in or around Lincoln, Nebraska, or indeed anywhere at all. We therefore determine that effects, if any, would not likely adversely affect listed species or critical habitat.

We also assessed the potential water quality impacts that may occur at larger regional scales due to smaller cumulative water quality impacts across the action area. We primarily relied on two analyses. The first is the same analysis that was used in the Set 1 BE, which analyzed published literature that used the SWAT to estimate the water quality impacts from observed increases in cropland in the Missouri River basin from 2008–2016 (Chen et al., 2021). We found that modeled increases in total nitrogen and phosphorus would represent increases of approximately 0.8% and 2.1% respectively at the Mississippi River outlet if we conservatively assume that the modeled increase in nitrogen and phosphorus at the mouth of the Missouri River was equal to the increase in nitrogen and phosphorus at the Mississippi River outlet. We expected that the increases in nitrogen and phosphorus from new cropland potentially attributable to the Set Rule would be similar to these SWAT results. We also estimated that any increase in pesticides in aquatic environments would be approximately equal to the potential increases in nitrogen and phosphorus projected using SWAT. While these estimates are not based on the Set 2 volumes, they can conceptually be similarly applied and scaled to the changes for the Set 2 Rule.

Additionally, to supplement this, we also performed a new historical nutrient trends analysis that analyzed changes in phosphorous, nitrogen, and sediment loads over the 2000s, 2010s, and early 2020s to estimate the water quality impacts from observed increases in cropland, especially cropland used for biofuel feedstock production. We acknowledge that there are likely more and different observable trends in water nutrient concentrations at more granular spatial scales; however, given the national scale of this rulemaking and the inherent uncertainty of the land use change analysis, we focused the water quality analysis on the national scale. We found that on a national scale, there were no major trends over the modeled periods in agricultural nutrient sources, growing season nutrient concentrations, or watershed export of sediment, total nitrogen, and total phosphorous, despite increases in agricultural activity such as crop removal, crop nitrogen fixation, and livestock production since the early 2000s. Much of this can be attributed to growing efficiencies in agriculture since the early 2000s. Agricultural nutrient surplus has largely plateaued since the 70s and 80s, with a slight increase in nitrogen in more recent years, but a similar decrease for phosphorous. In surface rivers, lakes, and streams, generally no change in N and P concentrations were observed from 2008 to 2022, or improvements in water quality were seen. A clustering analysis performed to visualize watershed nutrient export trends found that nutrient loading trends are variable, but watershed export is generally declining or stable throughout the biofuel expansion period, especially in recent years.

With regard to coastal and marine species, such as the NMFS species identified in the action area, the potential water quality impacts from the RFS Set 2 Rule would be either discountable (for offshore species) or undetectable and not measurable relative to existing conditions and would not rise to the level of take. The latter would likely be the case for potential effects in estuarine and coastal regions found in the action area, though we expect that downstream impacts, if they were to occur, would mostly take place in the Gulf of America region. Potential effects from the action would be discountable or insignificant for species that live offshore as well as species that occur along the coast in more shallow waters. Potential effects on NMFS species that migrate to headwaters of streams and rivers for spawning (e.g., salmonids) would also be discountable, as supported by an additional qualitative analysis the

EPA completed in the Set 1 BE and updated for this BE. This updated Set 2 Rule analysis demonstrated very small percentage increases in total cropland within those species' critical habitats and ranges.

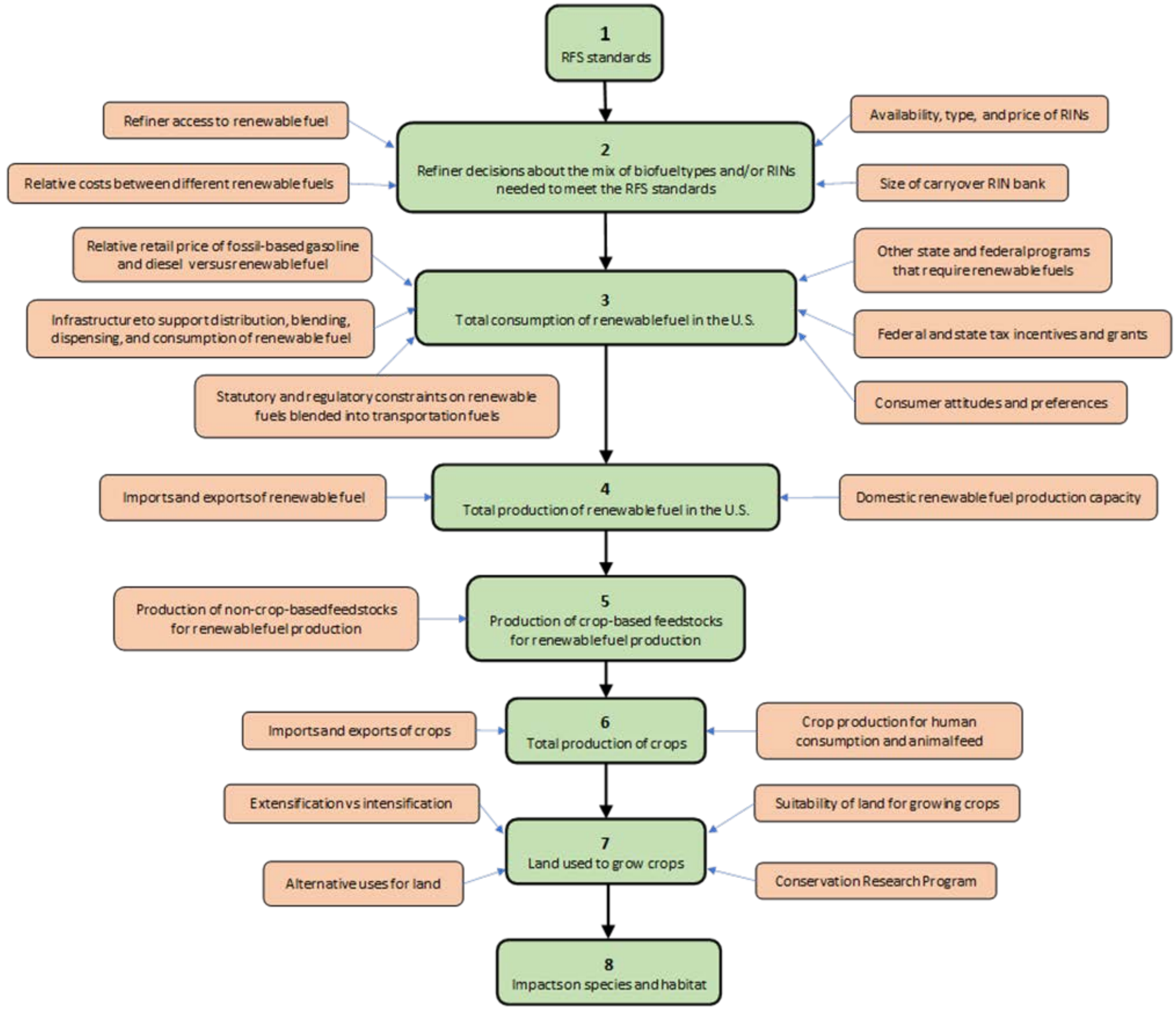
Furthermore, we note that the EPA currently has several programs designed to improve water quality. We would therefore expect that these ongoing efforts, discussed further in Section VIII.B, would reduce any water quality impacts of increased cropland potentially attributable to the Set 2 Rule.

In summary, our BE finds that the 821 populations with critical habitats and/or ranges within the action area may be affected. The potential impacts, however, would be insignificant or discountable and therefore we determine that the effects from the RFS Set 2 Rule are not likely to adversely affect species and critical habitats.

Appendix A. Overview of How the RFS Program Could Affect Listed Species and Critical Habitat via Land Use Change

The RFS program does not directly affect land use, listed species, or critical habitat. Instead, there is a multi-step causal chain between the standards and potential land use changes resulting from production of crops that involves several layers of third parties who are not subject to the RFS standards. The diagram below shows this causal chain.

Figure A-1: Causal Chain Between RFS Standards and Impacts on Species and Habitat



Stage 1: RFS standards

The applicable percentage standards under the RFS program provide the means through which each individual refiner determines its Renewable Volume Obligations (RVO). The RVOs represent the unique volume of renewable fuel that each refiner is responsible for ensuring is blended into gasoline and diesel. There are four separate RVOs as shown in Table III.A-1. Refiners can either blend renewable fuel into the gasoline and diesel they produce, or can purchase credits (Renewable Identification Numbers or RINs) from other parties who have done such blending.

Stage 2: Refiner decisions

While refiners must ensure that the renewable fuel volumes identified by their individual RVOs are used as transportation fuel, they are not required to use any particular type of renewable fuel. Insofar as a refiner is blending renewable fuel into its own gasoline and diesel, it can choose the mix of renewable fuel types it uses. Generally, refiners would be expected to do so in a way that minimizes overall costs, and this in turn is a function of the renewable fuels available to it and their relative costs, the relative amounts of gasoline and diesel that it produces, the equipment it has available to manage the production, storage, and blending of renewable fuel, and the demand for (or tolerance of) renewable fuels in the refiner's marketing area.

To the degree that a refiner chooses to purchase RINs instead of blending renewable fuel into its own gasoline and diesel (many refiners are in this position, as some or even all of the fuel they produce is sold to others for subsequent blending), however, the refiner has little control over the mix of renewable fuels used as transportation fuel. RINs are not specific to fuel type and feedstock, but instead are designated only as qualifying for one (or more) of the four categories shown in Table III.A-1. Renewable fuel producers decide what renewable fuels to produce and from what feedstocks based on market demand. Parties downstream of the refiner make decisions about what specific types of renewable fuels are blended into gasoline or diesel or are otherwise used as transportation fuel, and make the RINs associated with that renewable fuel available for sale to refiners. Consumers ultimately make the fuel purchase decisions for the fuels and the renewable fuels they contain. As for refiners, all parties would be expected to make decisions that maximize profit potential and/or minimize cost.

Stage 3: Total consumption of renewable fuel

While the RFS program requires minimum volumes of renewable fuel to be used in the transportation sector, actual total consumption of renewable fuel can and in some cases has been higher under appropriate economic circumstances. The total volume of renewable fuel consumed in the U.S. includes some that is used outside of the transportation sector and which, as a result, does not qualify under the RFS program. Finally, the total volume of renewable fuel produced in the U.S. includes volumes that are exported and consumed outside of the U.S., which again does not qualify under the RFS program.

There are a number of other state and federal programs that also require or incentivize the use of renewable fuel confounding attempts to assess the impacts of the RFS program alone. For instance, Minnesota requires that diesel fuel contain an average of 11% biodiesel, while California's Low Carbon Fuel Standard (LCFS) creates a demand for various advanced biofuels. Other states have similar requirements. The federal reformulated gasoline program does not require the use of an oxygenate, but the applicable emission standards are generally more difficult (i.e., more costly) to meet without the use of ethanol. A biodiesel tax credit of $1 per gallon was originally established by the Energy Policy Act of 2005 and has temporarily expired and been retroactively reinstated multiple times since then. A number of states offer tax subsidies that offset the production costs of renewable fuels, making them more attractive to consumers. And some vehicle fleets owned by state or federal agencies are required to refuel on renewable fuel when it is available.

At the retail level, the consumption of renewable fuel is driven primarily by their price in comparison to petroleum-based gasoline and diesel. Retail prices are a function of the cost of production which in the case of both renewable fuels and petroleum-based gasoline and diesel is in turn driven primarily by the costs of the feedstocks. Thus, to a large degree the economic attractiveness of renewable fuel to consumers is a function of crude oil prices and crop prices. Consumer choices about whether, how much, and what type of renewable fuel to consume can also be influenced by other factors such as perceptions of the impacts that renewable fuels may have on vehicles or engines, the impact that renewable fuels have on the environment, or the benefits of renewable fuels to rural economic development and farmers.

Certain constraints on renewable fuel use can also affect the mix of fuel types that are consumed. For instance, gasoline that can be used in all vehicles can contain no more than 10% ethanol (E10). While higher ethanol blends such as E15 and E85 are also possible, they can only be used in certain vehicles and the fraction of retail service stations offering such blends is very small. As a result, most ethanol blending occurs as E10 with limited volumes of higher level ethanol blends. Higher volumes of renewable fuel consumption typically comes in the form of non-ethanol renewable fuels such as biodiesel, renewable diesel, and biogas. For biogas used in CNG vehicles, the number of CNG vehicles in the current fleet places an upper bound on the total volume of biogas that can be consumed.

Thus, in addition to the RFS program standards, there are a wide variety of factors that can influence the actual consumption of renewable fuel, both in terms of total volumes as well as the mix of types of renewable fuel. These consumption-side factors strongly influence the choices that upstream parties make in terms of which renewable fuels to produce and blend into gasoline and diesel.

Stage 4: Total production of renewable fuel

While domestic production of renewable fuel is largely a function of domestic demand, other factors also influence what is produced and how much. Domestic renewable fuel production capacity places a limit on how much of each type of renewable fuel can be produced. As the production of one type of renewable fuel approaches its production capacity limit, additional volumes must come from other types of renewable fuel. For instance, the production capacity of liquid cellulosic biofuels remains very low, and cellulosic biogas for use in CNG engines has proliferated.

Imports and exports of renewable fuel also influence domestic production volumes. In recent years, the primary fuel types that have been imported are biodiesel, renewable diesel, and ethanol, in total representing about 5% of domestic consumption. Smaller amounts of biogas have also been imported. Greater import volumes generally mean that there is less need for domestic production in order to meet the RFS standards. Exports of renewable fuel, in contrast, generally mean that domestic production is higher than what is needed to meet the RFS standards. However, volumes that are produced domestically and then exported cannot be attributed to the RFS program since they are being used to meet foreign demand. Over the last several years, the primary type of renewable fuel exported has been ethanol, though not insignificant volumes of biodiesel have also been exported. In total, these exports represent about 10% of domestic consumption over the last several years.

Stage 5: Production of crop-based feedstocks

The fraction of total renewable fuel production that is derived from crop-based feedstocks is a function of their cost, availability, and ease with which they can be converted into renewable fuel in comparison to non-crop-based feedstocks. Each renewable fuel producer decides which feedstocks they will use to produce renewable fuel, and those decisions determine the renewable fuel category into which that renewable fuel falls. The choice of feedstock also likely impacts the selling price of that fuel. Downstream parties such as blenders and distributors will make their own choices about which biofuels to purchase, and can be expected to make choices based primarily on price. Few downstream parties have an incentive to make fuel purchasing choices based directly on feedstock, and more importantly they rarely have sufficient access to information about feedstocks to enable them to do so.

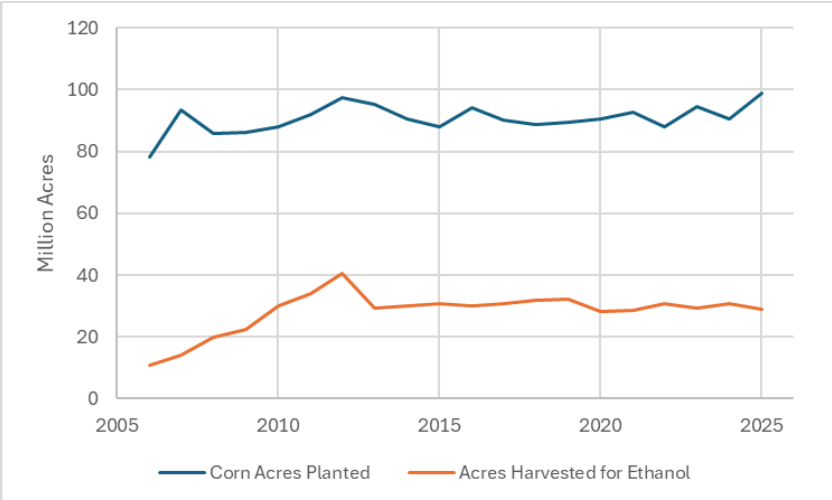
The driving factors for competing feedstocks have different outcomes for each of the renewable fuel categories shown in Figure III.A-1. As described previously, essentially all cellulosic biofuel has been derived from the non-crop feedstock biogas, while essentially all conventional renewable fuel has been derived from the crop-based feedstock corn. For non-cellulosic advanced biofuel, composed predominately of biodiesel, crop-based feedstocks have represented on average 56% of total domestic production over the last several years.

Stage 6: Total production of crops

Individual farmers choose what crops they will grow based primarily on projected grain and oilseed market prices, but their choices also depend on the land available to them and its suitability for growing certain crops. They do not grow particular crops for the purposes of meeting demand for renewable fuel or any other particular end use. Moreover, their choices can and often do change from year to year. Actual crop production is also affected by climate, the availability of irrigation water, and a host of other factors.

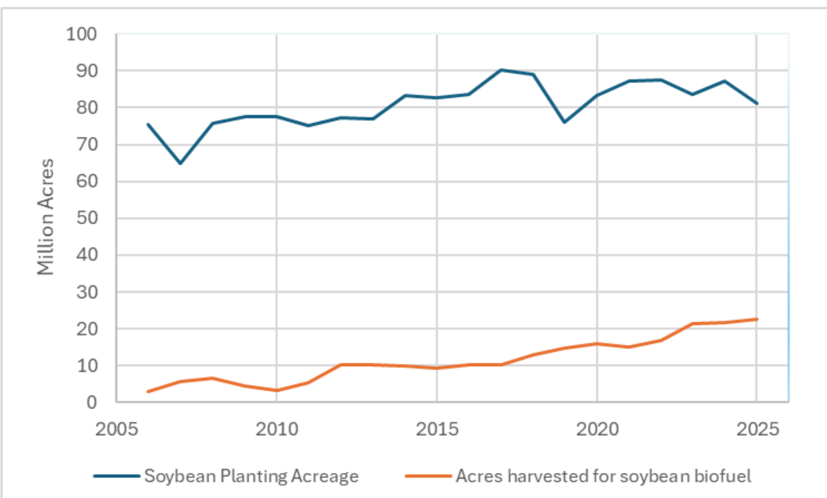
Crops are grown for a variety of purposes in addition to renewable fuel. These include food, animal feed, and various industrial and manufacturing processes. Between 2016 and 2025, an average of about 32% of domestic corn production was used for fuel ethanol, while an average of about 36% of domestic soybean oil (representing about 19% of domestic soybean production) was used for biodiesel (USDA Economic Research Service, 2025a). Figures A-2 and 3 show the yearly corn and soybean acreage used for biofuel production relative to total corn and soybean planted acreage in the United States.

Figure A-2: U.S. Corn Cropland Used for Ethanol



Source: USDA's Economic Research Service.

Figure A-3: U.S. Soybean Cropland Used for Oil for Biodiesel Production



Source: USDA's Economic Research Service-Oil Crops Yearbook.

As for domestic renewable fuel production, domestic crop production is affected by imports and exports of crops for their many other uses including food and feed. Imported crops reduce the need for domestic production, while exported crops cannot be attributed to the RFS program since they meet foreign demand. Between 2016 and 2024, corn imports have remained low but varied with need from drought years, but 18% of corn grown in the U.S. has been exported. Almost no soybeans have been imported, but on average 49% of domestically grown soybeans have been exported.

Attempts to model where biofuel feedstocks might be grown in the future, even at a coarse level, rely on a range of assumptions that result in widely different conclusions. One analysis used two types of models—GTAP-BIO and GLOBIOM—to predict land use change effects that may occur in the United States from increased biofuel production from soybean oil. While the GTAP-BIO model predicted that crop switching (i.e., a decrease in the use of cropland for non-biofuel crops accompanied by an increase in the use of cropland for soybeans for biofuel) on existing croplands would be the dominant change to supply the additional soybean oil feedstock, the GLOBIOM model predicted crop-switching to be low and instead showed major changes to natural and abandoned lands (International Civil Aviation Organization, 2019). Another study by Zhao et al. (2021) used GTAP-BIO to estimate the land use impacts from increasing jet fuel and renewable diesel production from soybean oil in the U.S. by about two billion gallons. They projected a fair amount of crop switching in the U.S. and small increases in total cropland (Zhao et al., 2021).

In the vast majority of cases, farmers do not know which bushels they produce will be used to produce renewable fuel. Instead, farmers sell their crops to distributors (e.g., grain elevators) who meet the regional demand for the crops they collect. Bushels can change hands multiple times before they reach their final destination, and as fungible commodities those bushels are often mixed together without regard for their farm of origin. Nevertheless, in very general terms it is likely that crops used to produce renewable fuel are more likely to be grown near a renewable fuel production facility than further away. A study by Wright et al. (2017) assessed land use changes from 2008 to 2012 and found that the rate of grassland conversion to cropland increased with proximity to a biorefinery location. Other studies that quantitatively correlate crop production with distance to a production facility have shown similar results (Austin et al., 2022).

Stage 7: Land used to grow crops

Not only do individual farmers choose what crops they will grow, they also choose what land they will use to grow those crops based upon the availability of land, their rights to grow crops on that land, and its suitability for particular crop types. If a farmer chooses to increase production of a particular crop, he can do so through conversion of non-cropland to crop production if there is suitable land available to him to do so ("extensification"). But he can also increase production of a particular crop without increasing total land used through one of several different "intensification" methods:

- Increase the density of rows, plants, or plant closer to the edges of fields.
  - This is one of the most common forms of intensification.
- Reduce production of one crop type and increase production of another crop type.
- Increase the yield of an existing crop through increased use of fertilizer, herbicides, pesticides, and/or fungicides.
- Harvest two crops in a single year from the same plot of land (so-called double-cropping or multi-cropping).
  - This is not common in the U.S.

In these intensification cases, total land used to produce crops remains unchanged, but farming activities may change (e.g. application rates for fertilizer or pesticides, frequency of equipment use, irrigation needs). Since farmers make decisions about extensification versus intensification based on their particular circumstances, there is no straightforward way to predict what those choices will be for total cropland writ large.

Stage 8: Impacts on species and habitat

Changes in the way that land is used to grow crops can impact species and habitat in several ways. Non-cropland that is converted to cropland can result in adverse effects to habitats within the range of listed species, and nearby habitats can indirectly be affected by the noise, dust, or runoff created during the land conversion. After conversion, the new cropland can also affect listed species or habitat on both the land in question and nearby areas through sediment, pesticide, herbicide, or fertilizer runoff. Similarly, in cases where additional crops are grown on existing cropland through various intensification measures such as double-cropping or increased fertilizer or pesticide use, there can be impacts on flora and fauna for that land and nearby areas.

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