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Monarch Population Development: A stage specific model

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STAGE SPECIFIC ANALYSIS OF POPULATION TRENDS

Monarch numbers each season are due to:

timing and number entering each stage and the -

abundance, distribution, quality of milkweeds + nectar

followed by impact of weather, parasites, predators,
pathogens on numbers entering the next stage

S1 Overwintering

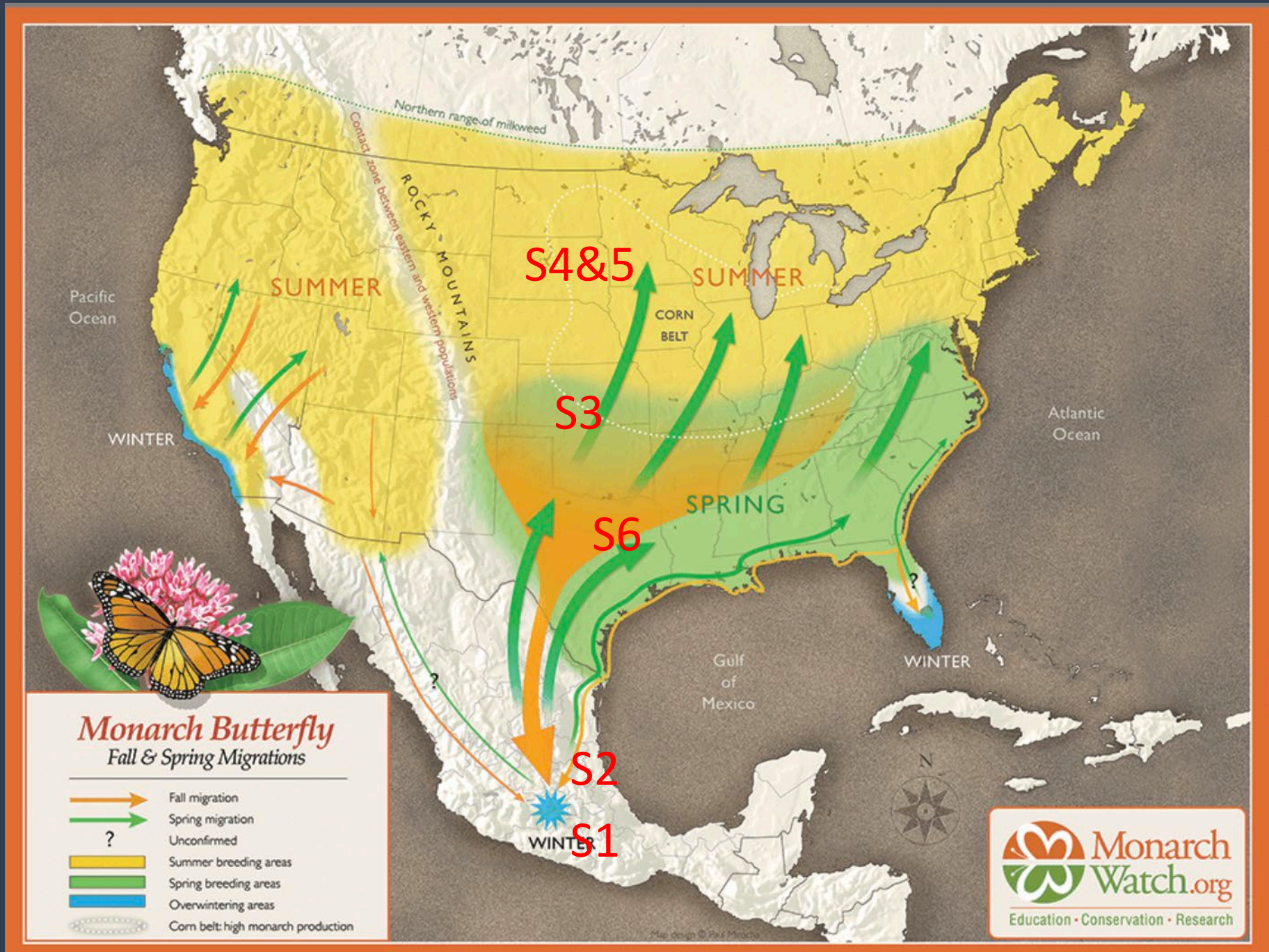
S2 Return migration

S3 Breeding

S4 Recolonization

S5 Summer generations

S6 Fall migration



MONARCH POPULATIONS – A STAGE SPECIFIC MODEL

Winter in Mexico –Nov – Ap

Spring return through Mexico to Texas Feb-Ap

Development first generation South Region Mar –Ap

Recolonization northern areas by first generation May – Jn

Summer population growth Jn-Aug

Fall migration Aug-Dec

FACTORS FAVORING REPRODUCTIVE SUCCESS (REALIZED FECUNDITY)

LOW TO MODERATE TEMPERATURES, WIND SPEEDS AND RAINFALL

ABUNDANT NECTAR

HOST PLANT DISTRIBUTION, ABUNDANCE AND QUALITY

SUFFICIENT NUMBER OF MATES

ABSENCE OF OR MINIMAL PRESENCE OF PREDATORS AND PARASITES

TEMPERATURE – POSITIVE AND NEGATIVE*

POSITIVE - within +/-2F OF AVERAGE

NEGATIVE - more than +2F

NEGATIVE less than -2F

MAXIMUM FEMALE LIFE

SHORTENS FEMALE LIFE IF >+2F

Long generations

MAXIMUM EGG LAYING

REDUCES EGG LAYING

REDUCES EGG LAYING

FAVORS PLANT GROWTH/QUALITY/NECTAR

REDUCES PLANT GROWTH /QUALITY

SLOWS PLANT GROWTH

ACCELERATES OR SLOWS LARVAL GROWTH

LARVAE –SLOWS GROWTH +STRESS

REDUCES GENERATIONS

*THE IMPACTS OF TEMPERATURE EXTREMES VARY WITH THE SEASONS. HIGH TEMPERATURES CAN ENHANCE DISPERSAL IN THE SPRING AND SLOW THE MIGRATION IN THE FALL

DATA SETS – EAST VS WEST

- EAST
 - Winter counts
 - First sightings March+April
 - First sightings May+mid-June
 - Eggs per stem
 - Numbers tagged
 - Fall roosts
 - Cape May – Pollard counts
 - NDVI
 - Summer counts – NABA, etc.
- WEST
 - Fall/winter counts
 - Journey North First Sightings
 - iNaturalist sightings

PREDICTIONS – EAST VS WEST

- EAST
 - May – increase vs decrease
 - June – summer numbers
 - June – O.e. increase or decrease
 - August – size of migration
 - November – winter numbers
- WEST
 - None
 - 4 sources/weather
 - No colonization data
 - No summer counts
 - No migration data
 - No data / reproductive success

ASSUMPTIONS

1. YEARLY COUNTS ARE AN ACCURATE MEASURE OF THE POPULATION
 - A. COUNTING EFFORT IS THE SAME FROM YEAR TO YEAR
 - B. ALL LARGE COLONIES ARE VISITED EACH YEAR
 - C. SHIFTS NORTHWARD OR AMONG LOCATIONS DO NOT AFFECT COUNTS
2. MEAN TEMPERATURES AND PRECIPITATION ACCURATELY REFLECT CONDITIONS THAT AFFECT BIRTH AND DEATH RATES
3. STAGES USED TRULY REPRESENT RELEVANT PROCESSES FOR THE WESTERN POPULATION
4. POSITIVE AND NEGATIVE IMPACTS OF PHYSICAL FACTORS (AS DERIVED FROM THE EAST) APPLY TO THE WEST
5. CONTRIBUTIONS TO OVERWINTERING NUMBERS ARE RELATIVELY SIMILAR EACH YEAR AMONG WEST REGIONS

DATA GAPS

OVERWINTERING MORTALITY – AVERAGE AND STORM RELATED

VARIATION IN DATES OF COLONY BREAKUP

MONARCH PRODUCTION IN EACH REGION – MORE ISOTOPE DATA NEEDED – WITH CONTROLS

MOVEMENT OF FIRST GENERATION MONARCHS FURTHER TO THE N AND E

LATE SUMMER/FALL MIGRATION

YEAR TO YEAR VARIATION IN COLONY ESTABLISHMENT

LOCATIONS OF FALL AND WINTER RESOURCES - WATER AND NECTAR

HABITAT LOSS

CONCLUSIONS

ENVIRONMENTAL ISSUES

Facts

MEAN TEMPERATURES ALONG THE CALIFORNIA COAST HAVE INCREASED BY AN AVERAGE OF 2F SINCE 2000.

NUMBERS OF OVERWINTERING SITES AND MONARCHS ARE DECLINING IN SOUTHERN CALIFORNIA COUNTIES.

NORTHERN COUNTIES NOW CONTAIN HIGHER PROPORTIONS OF THE TOTAL OVERWINTERING MONARCHS.

Predictions

TEMPERATURE INCREASES DURING FALL AND WINTER OVER THE NEXT 20 YEARS WILL IMPACT THE NUMBER AND DISTRIBUTION OF OVERWINTERING SITES.

HIGHER BREEDING SEASON TEMPERATURES AND DROUGHTS WILL HAVE A NEGATIVE IMPACT ON POPULATION GROWTH.

INCREASING NUMBERS OF DAYS >100F WILL REDUCE THE MONARCH BREEDING RANGE.

CONCLUSIONS

Applies to East and West

INCREASES ARE ASSOCIATED WITH TEMPERATURES CLOSE TO THE LONG TERM AVERAGES

DECREASES ARE ASSOCIATED WITH BOTH EXTREME HIGH AND LOW AVERAGE TEMPERATURES

Applies to West

POPULATION SIZES FROM 2001-2016 AND 2021 - 2022 INDICATE HABITAT LOSS IS NOT THE MAJOR DRIVER OF MONARCH NUMBERS IN THE WEST.

CONTRIBUTIONS TO OVERWINTERING COLONIES FROM NW AND W VARY FROM YEAR TO YEAR.

THE STAGE SPECIFIC MODEL PREDICTS THE DIRECTION OF POPULATION CHANGE (13/18) BUT NOT THE AMPLITUDE.

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