

Epidemiology
Research
Group in
Organ
Transplantation



JOHNS HOPKINS
M E D I C I N E

Optimized redistricting of liver allocation: Exploring the impact of choices by the transplant community

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Disclosures

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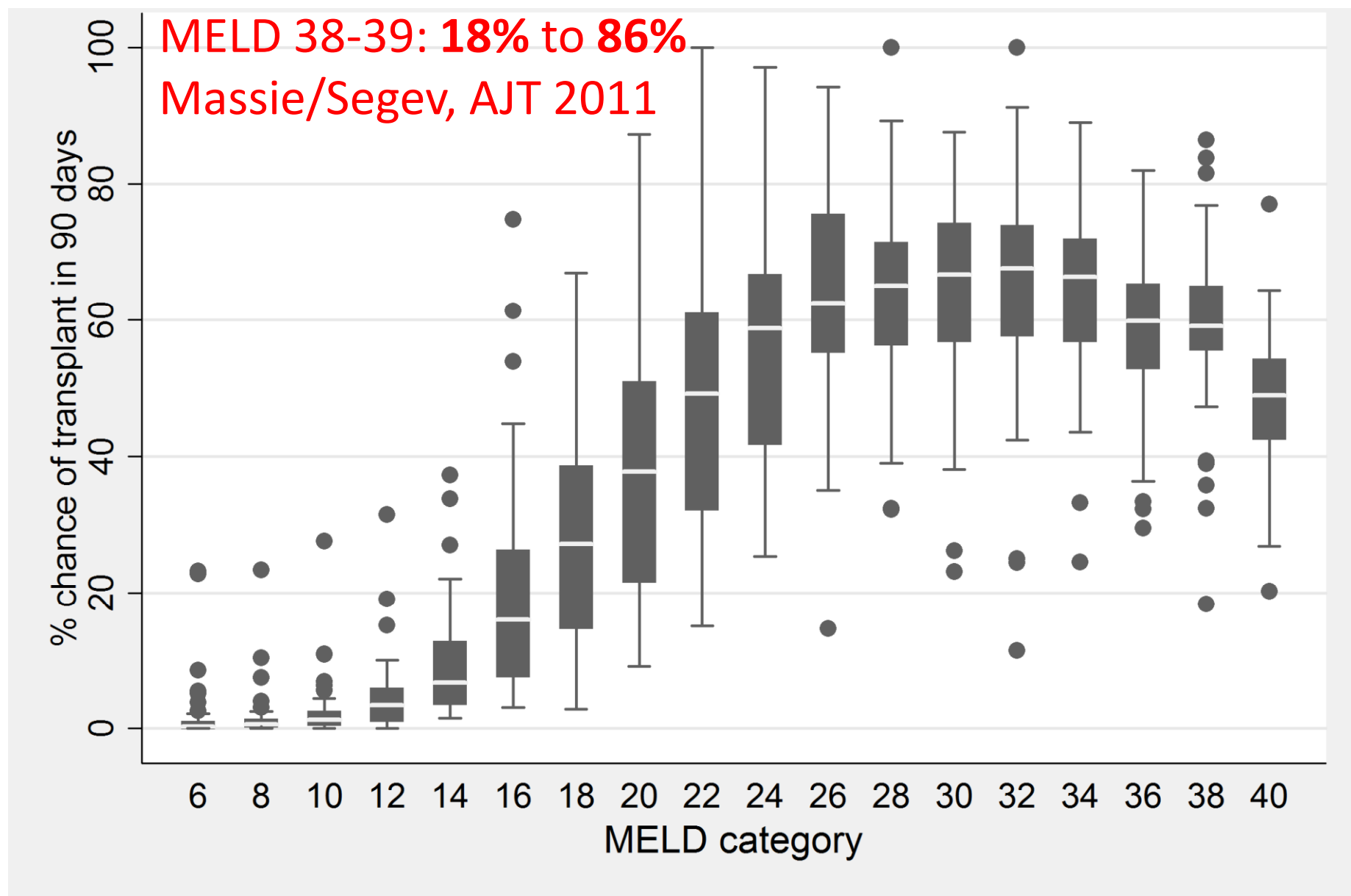
United States Naval Academy, Annapolis Maryland

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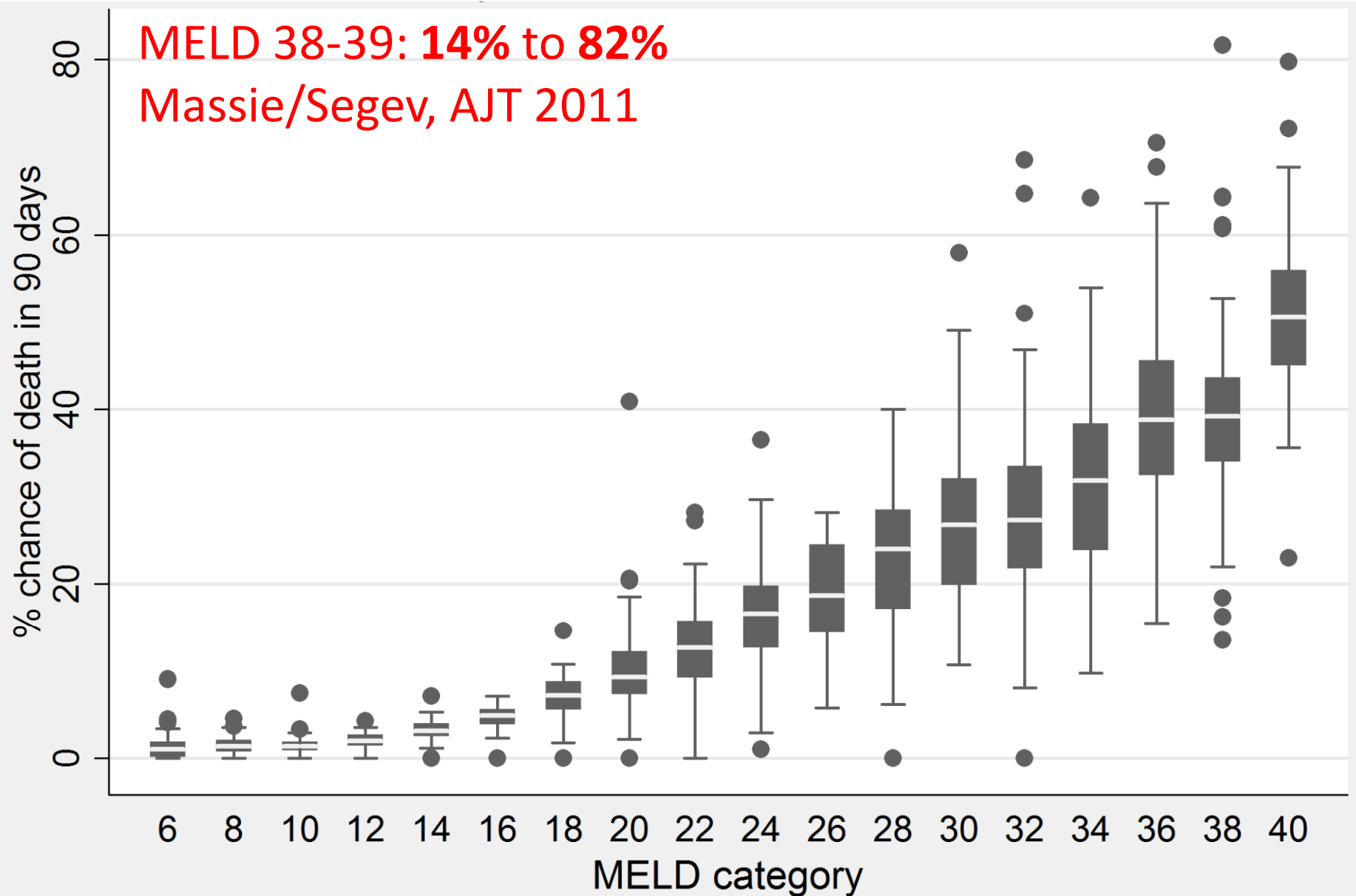
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Motivation: Transplant Rates, by OPO



Motivation: Death Rates, by OPO



Final rule: “Neither place of residence nor place of listing shall be a major determinant of access to a transplant.”

Optimized Redistricting

- The OPTN's Liver Committee voted
 - To establish the goal of redistricting optimization: to reduce geographic disparity in liver transplant
 - To establish constraints on redistricting, such as number of districts and transport time limits
- We used mathematical optimization to find allocation district designs with the lowest geographic disparity possible under the constraints, keeping OPO boundaries intact

Disparity Metrics

- Rather than describe an overall outcome, disparity metrics directly measure ***by how much outcomes differ*** for people living in different parts of the country
 - *LSAM evaluation of redistricting: Standard deviation of median MELD at transplant among OPOs*
 - *For mathematical optimization: number of livers directed away from most medically urgent patients*

Redistricting goal: Minimize disparity

- Minimize *total disparity*
 - Disparity = difference between P_i , the number of transplants for a potential district (if 2010 organs went to highest MELD patient listed in 2010 anywhere in the country) and D_i , the number of donors available in 2010 in a potential district
 - Minimize sum of these disparities over all districts:

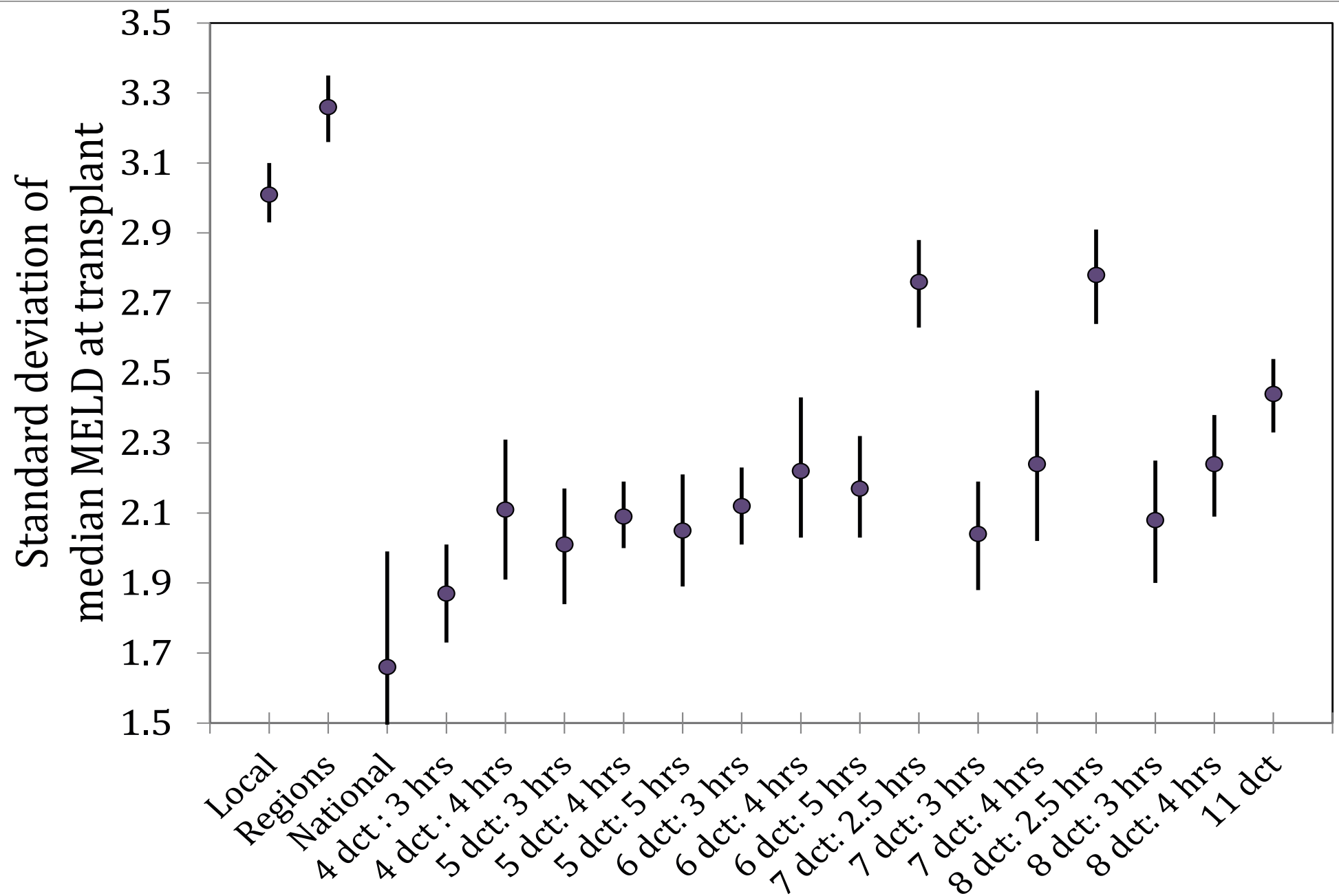
$$\text{Minimize } \sum_{i \in \text{Districts}} |D_i - P_i|$$

- Subject to constraints

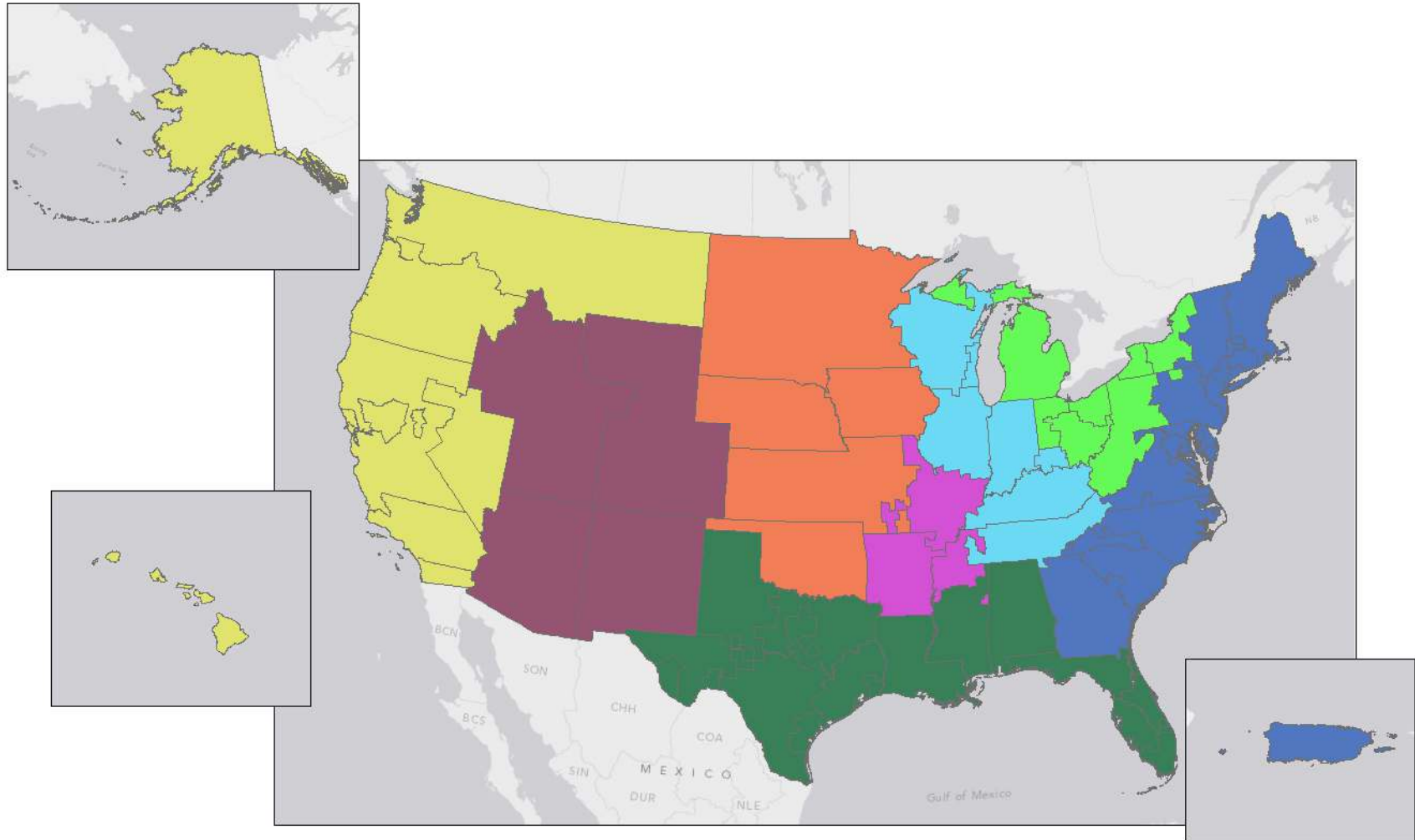
Liver Committee's Constraints

- The number of districts should be at least 4 and no more than 8.
- Minimum number of transplant centers per district is 6.
- The transplant-volume-weighted average transport time between OPOs placed in the same district should be either 4 hours or 5 hours.
- The number of waitlist deaths under redistricting must not be statistically significantly higher than in the current system.

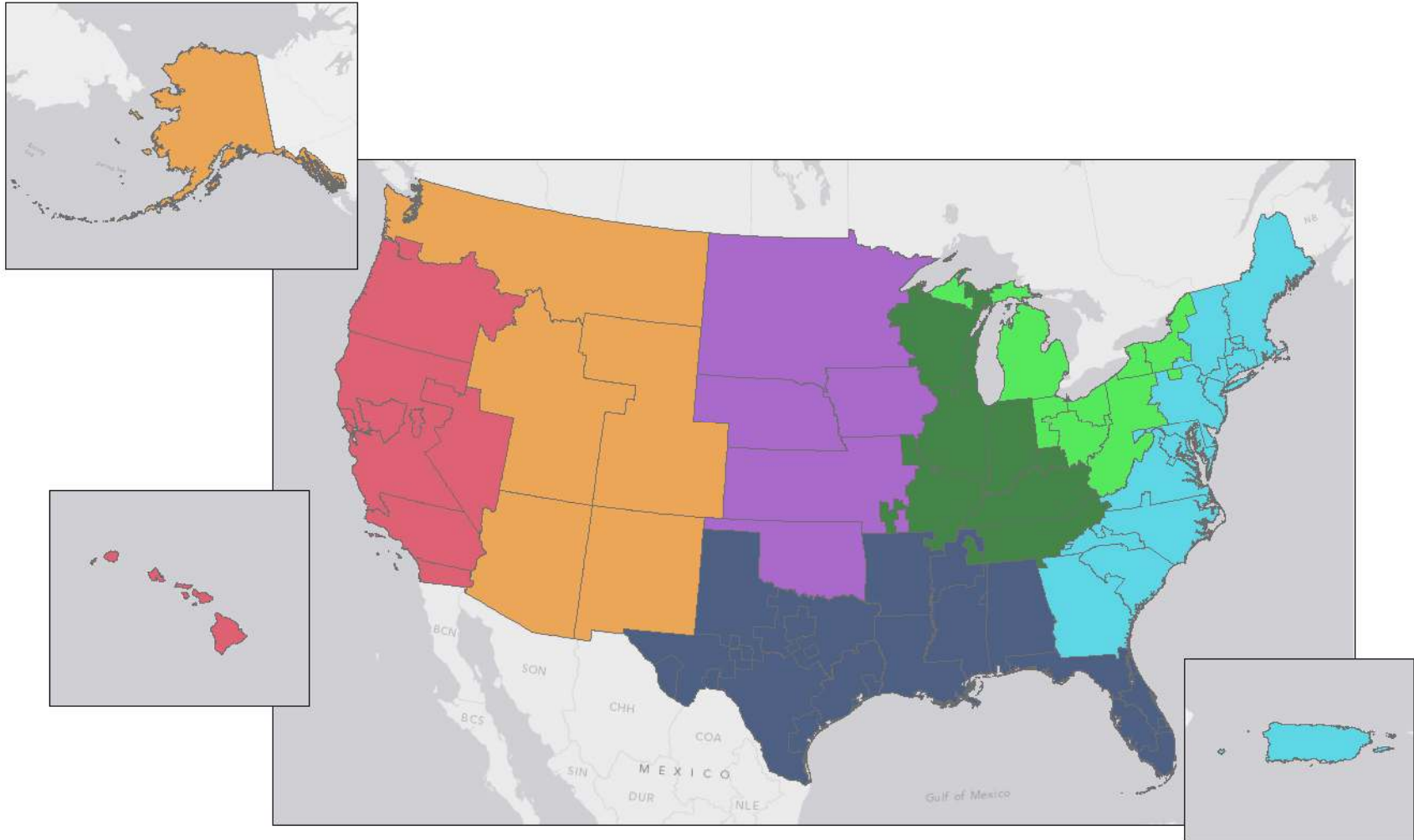
Disparity tradeoff: transport constraint



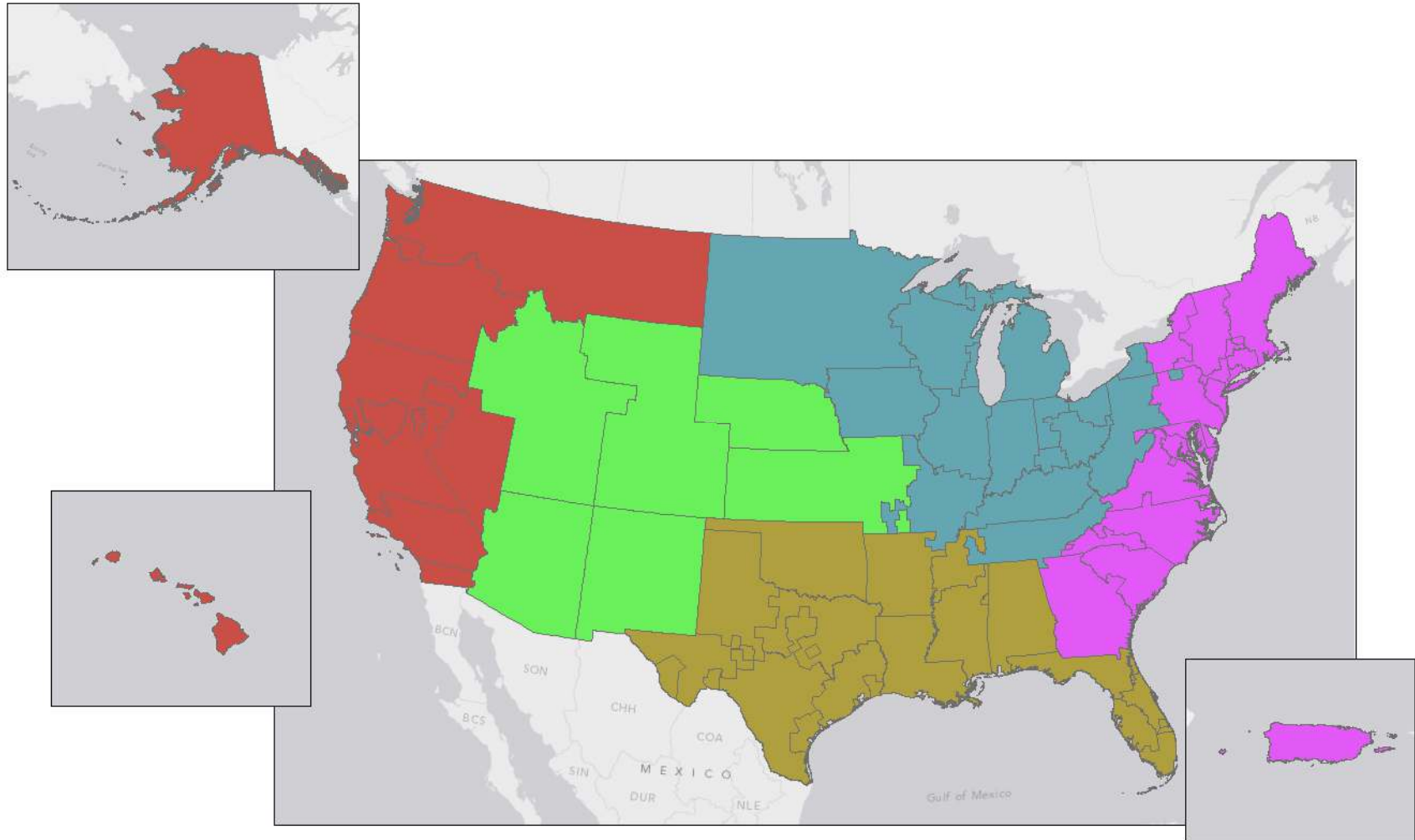
8 districts, 3 hour limit



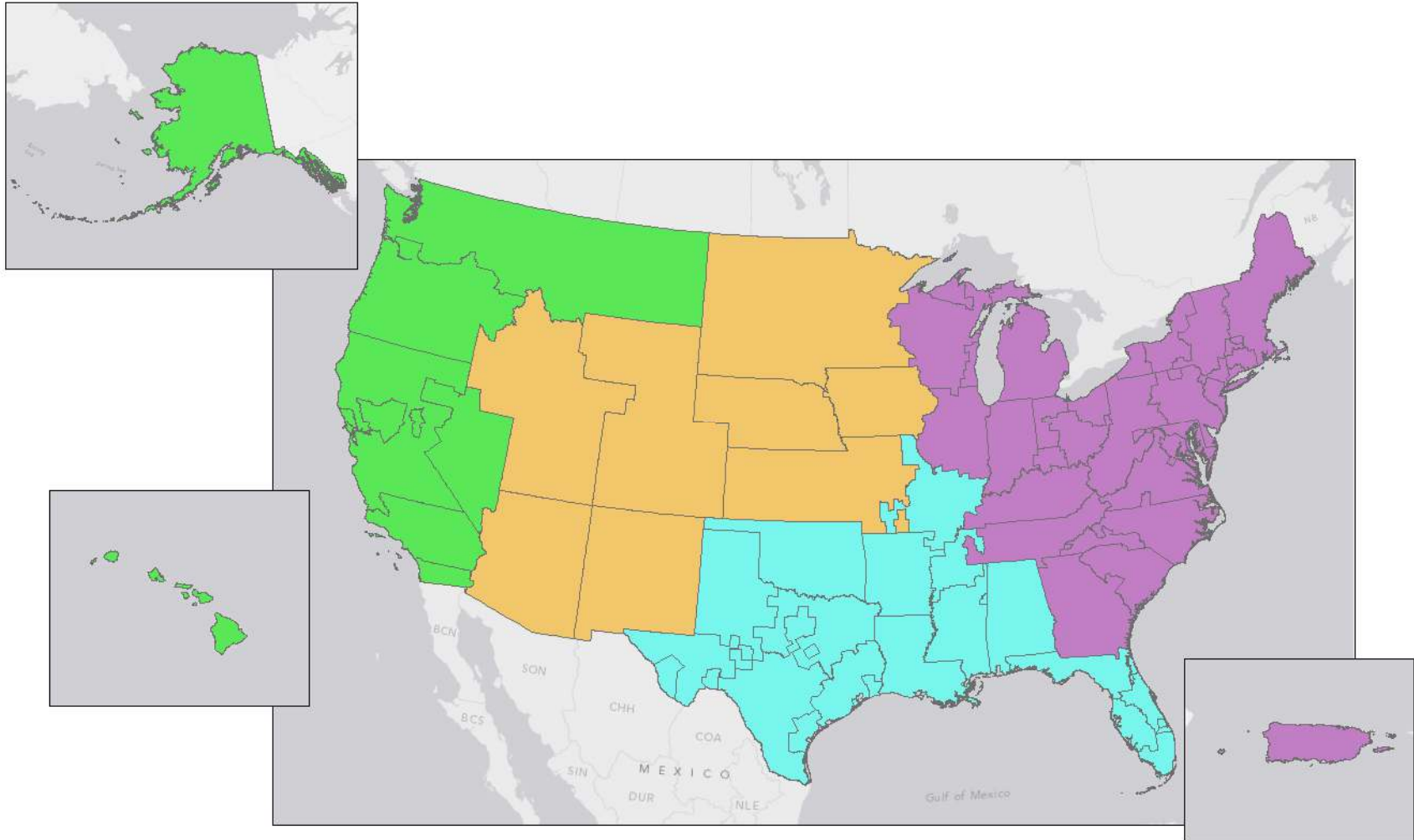
7 districts, 3 hour limit



5 districts, 3 hour limit



4 districts, 3 hour limit



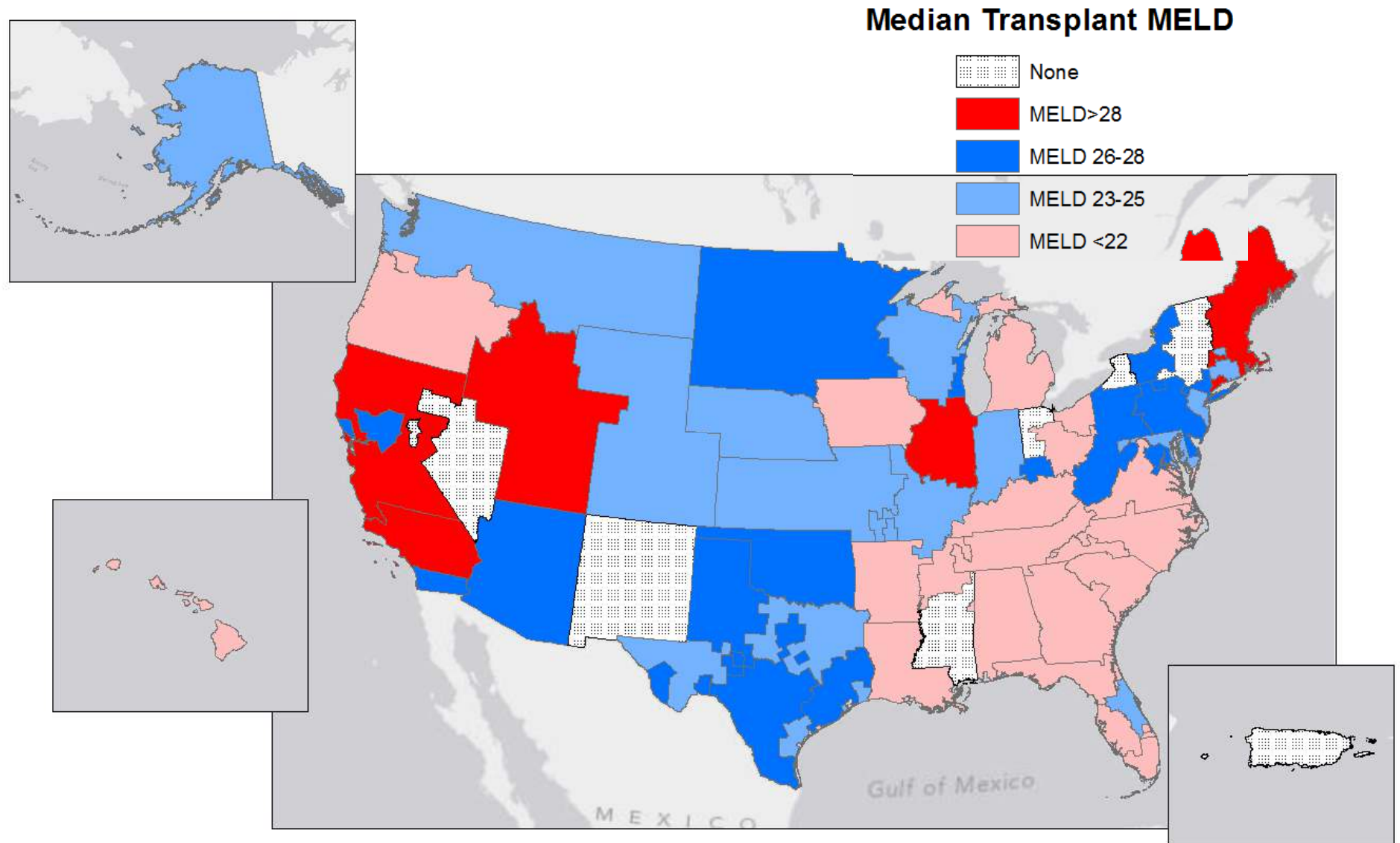
LSAM comparison of allocation plans

Districts	Median distance	<i>Median hours transport</i>	% flying	<i>Waitlist deaths (vs. local)</i>	<i>Standard deviation of tx MELD</i>
4	340	2.05	74%	-581.1	<u>1.87</u>
5	254	1.91	73%	-441.8	<u>2.01</u>
6	232	1.85	70%	-431.7	<u>2.01</u>
7	192	1.78	66%	-382.2	<u>2.04</u>
8	178	1.75	64%	-342.1	<u>2.08</u>
11	143	1.71	50%	-239.7	2.44
Local	68	1.5	44%	0	3.01
Regional	137	1.7	61%	-122.4	3.26

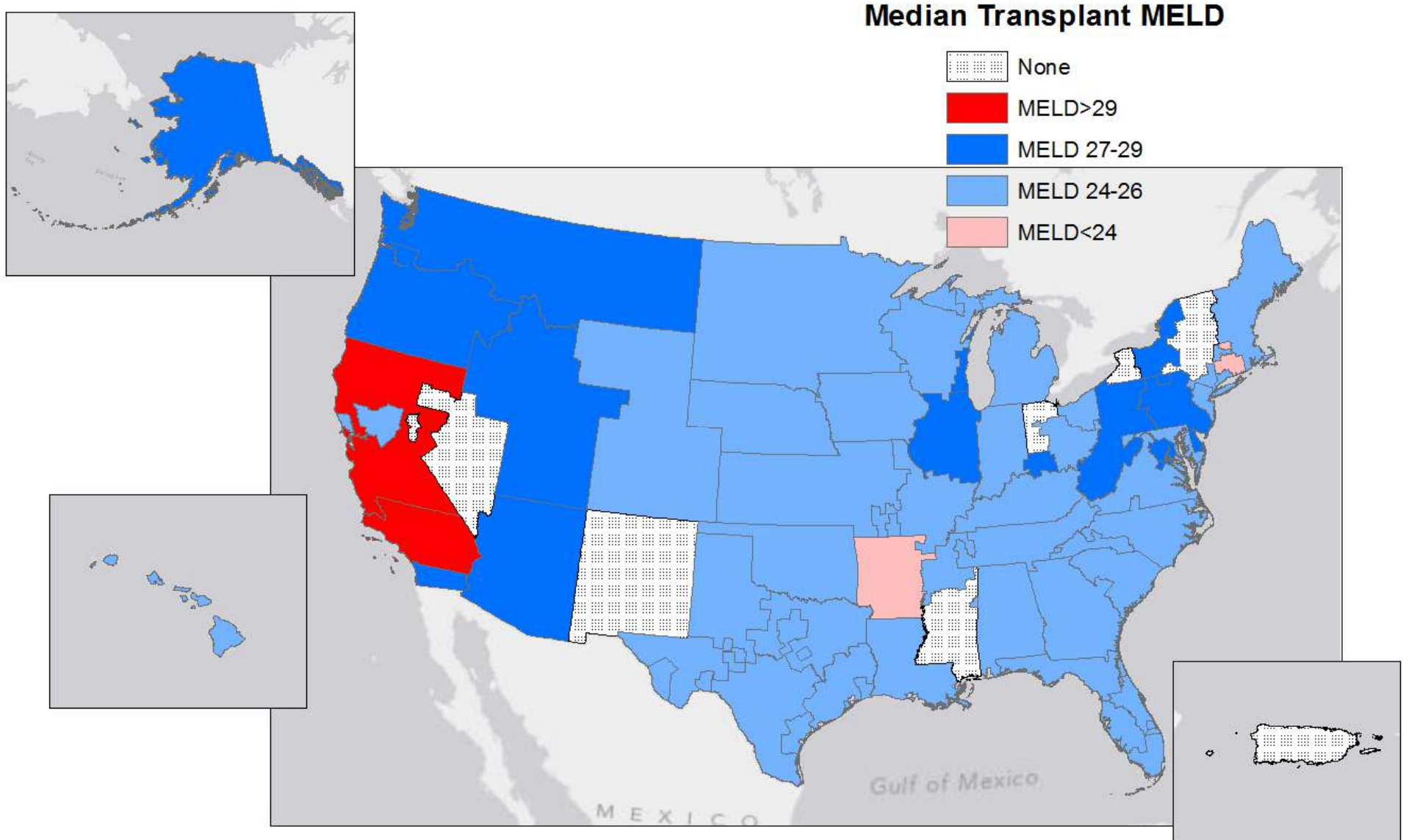
Median Transplant MELD

- None
- MELD >28
- MELD 26-28
- MELD 23-25
- MELD <22

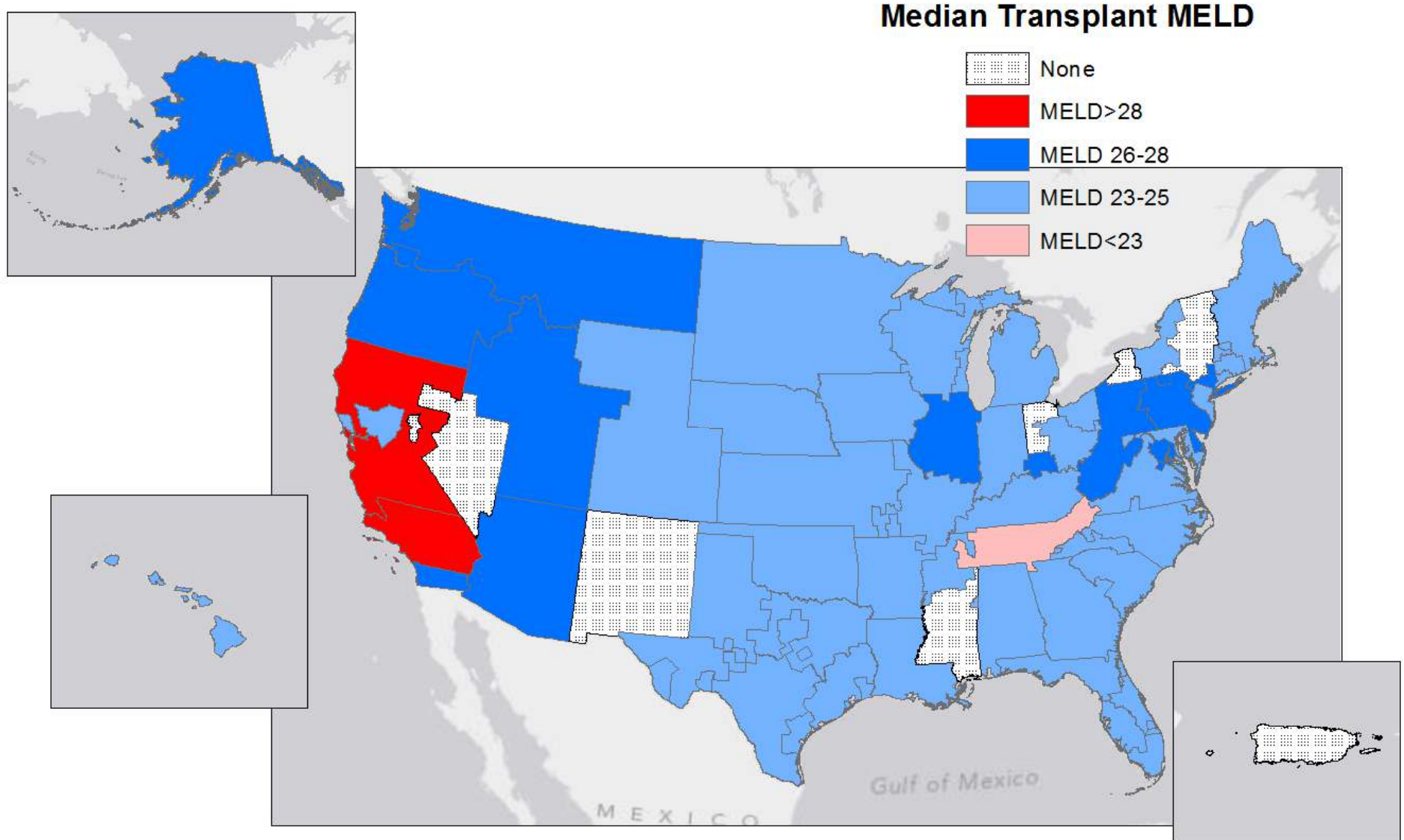
Regional sharing (2006-2011 LSAM)



4 district map reduces disparity



8 district map reduces disparity



Conclusions

- There is only a mild tradeoff between geographic disparity and transport impacts.
- Implementing any of the redistricting maps will significantly improve geographic equity compared with either current allocation or regional sharing with the existing regions.
- Maps with fewer districts require a higher cost in terms of transport, but might do more to reduce waitlist death.

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