

**MEMBANGUN MODEL DINAMIK SISTEM PENGELOLAAN  
PERIKANAN DI SELAT MAKASSAR MENGGUNAKAN SOFTWARE  
STELLA**

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## RINGKASAN

Pemanfaatan sumberdaya alam memerlukan sistem pengelolaan yang dapat memanfaatkan sumberdaya secara maksimum dan lestari. Sistem pengelolaan perikanan khususnya perikanan tangkap di Selat Makassar perlu dukungan perencanaan dan regulasi yang tepat agar pemanfaatannya dapat secara lestari dan memberikan keuntungan maksimal. Apalagi dengan adanya program *toll laut* dalam poros maritim di wilayah ini dapat berdampak pada pemborosan anggaran dan kerugian negara dalam pembangunan pelabuhan jika tidak ditunjang oleh ketersediaan sumberdaya ikan secara berkelanjutan. Untuk itu sangat dibutuhkan adanya kajian yang dapat menghasilkan luaran yang dapat digunakan sebagai bahan pertimbangan dalam menetapkan kebijakan sistem pengelolaan perikanan di wilayah ini.

Salah satu tool yang banyak digunakan dalam studi untuk perencanaan pengelolaan sumberdaya perikanan adalah pemodelan dinamik. Alasannya adalah karena pemodelan dinamik dapat memberikan luaran yang mampu mengestimasi dampak sebuah kebijakan yang ditetapkan baik dalam jangka pendek maupun jangka panjang. Alasan lainnya adalah pendekatan pemodelan dinamik mampu mensimulasikan dan mengintegrasikan berbagai aspek yang terkait dalam sebuah sistem yang kompleks sehingga dengan pendekatan sistem tersebut memungkinkan untuk mendapatkan hasil yang lebih akurat, komprehensif dan memungkinkan untuk diterapkan.

Untuk membuat dan membangun model dinamik dapat dilakukan dengan menggunakan berbagai software. Salah satunya yang banyak digunakan untuk berbagai bidang adalah STELLA. Software ini sudah populer dan banyak digunakan dalam membangun dan mensimulasikan model dinamik pada berbagai bidang ilmu di berbagai negara. Meskipun demikian, penggunaan software ini dalam penelitian-penelitian di Indonesia masih terbatas pada bidang ilmu tertentu karena penguasaan secara teknis masih terbatas dalam kelompok-kelompok peneliti di beberapa kampus. Atas pertimbangan itulah sehingga karya ilmiah ini dibuat dengan tujuan untuk lebih memperkenalkan pemanfaatan model dinamik menggunakan STELLA khususnya dalam bidang ilmu pemanfaatan sumberdaya alam kelautan. Karya ilmiah ini menjelaskan bagaimana pemanfaatan dan menjelaskan secara umum bagaimana teknis membangun model dinamik (desain dan struktur model) beserta output yang dapat dihasilkan. Model yang dibangun dibatasi pada sistem perikanan yang terintegrasi dengan program tol laut di Selat Makassar. Desain dan struktur model, persamaan yang dibuat berikut hasil simulasi beberapa skenario akan disajikan dalam bentuk gambar dan grafik.

*Keyword : model dinamik, simulasi, system perikanan, STELLA, dan Selat Makassar*

## **PENDAHULUAN**

Populasi ikan yang multi spesies dan penangkapannya yang menggunakan berbagai jenis alat tangkap (multi gear) di Selat Makassar menyebabkan perlunya kajian yang mampu menjawab pertanyaan bahwa *“berapa banyak setiap spesies yang harus di tangkap, menggunakan alat tangkap apa, dimana menangkapnya dan kapan ditangkap sehingga populasi ikan dapat dimanfaatkan secara maksimum dan lestari?”* Keberlanjutan pemanfaatan sumberdaya memerlukan dukungan infra struktur untuk menaikkan nilai tambah secara ekonomis sehingga penempatan dan persebaran titik dimana infra struktur itu dibangun harus dihitung secara akurat. Model dinamik yang menggunakan pendekatan trofik level khususnya pada ikan pelagis kecil dengan alat tangkap bagan rambo di Selat Makassar menunjukkan bahwa penangkapan yang terlalu banyak pada trofik level rendah (ikan planktivora) menyebabkan menurunnya volume dan nilai hasil tangkapan (Hatta, 2010).

Penggunaan model dinamik untuk menyusun sebuah perencanaan sudah banyak dilakukan dalam berbagai kegiatan termasuk pengelolaan sumberdaya alam. Software STELLA merupakan salah satu tool yang banyak digunakan untuk membuat atau membangun dan mensimulasikan model dinamik. Untuk mendapatkan hasil maksimal maka aspek teknis dalam pembuatan model menggunakan STELLA sangat diperlukan. Beberapa hal penting yang dibutuhkan terkait pembuatan model dinamik menggunakan STELLA diantaranya : penyusunan konsep model, pembuatan design dan struktur model, formulasi persamaan, perumusan skenario dan simulasi serta interpretasi dan penyajian hasil simulasi. Pembahasan utama dalam karya ilmiah ini difokuskan pada penyusunan konsep, design dan struktur serta formulasi persamaan model dinamik.

## **PEMBUATAN MODEL DINAMIK**

### ***Konsep Model Dinamik***

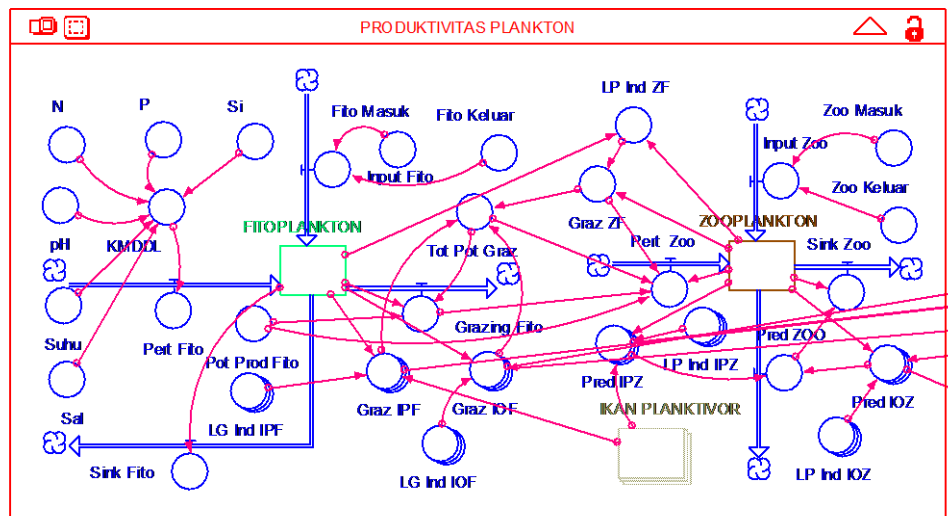
Konsep dasar model dinamik ini didasarkan pada teori dasar perpindahan energy melalui rantai makanan yang mempengaruhi biomassa ikan pada setiap jenjang trofik. Biomassa produksi primer yang dihasilkan oleh fitoplankton

menentukan besarnya produksi ikan yang ada dalam suatu wilayah perairan. Karena kelimpahan plankton dipengaruhi oleh kondisi lingkungan terutama nutrient dan mengalami dinamika sehingga parameter lingkungan juga akhirnya mempengaruhi produksi ikan. Produksi primer plankton memiliki keterbatasan dan daya dukung tertentu sehingga mempunyai daya dukung tertentu pula dalam menghasilkan biomassa ikan.

Apabila penangkapan dilakukan berlebih pada ikan trofik level rendah maka akan memutus rantai makanan dan menyebabkan degradasi populasi ikan pada trofik lebih tinggi akibat kurangnya sumberdaya makanannya. Hal ini akan mengganggu kelestarian sumberdaya ikan dan secara ekonomis tidak menguntungkan karena biasanya ikan pada trofik level rendah seperti ikan planktivora memiliki nilai ekonomis yang jauh lebih rendah dibandingkan dengan ikan karnivora pada trofik lebih tinggi. Oleh karena itu dengan konsep bahwa apabila penangkapan diatur dengan quota tertentu pada setiap jenjang trofik maka akan memberikan hasil maksimum dan menyebabkan sumberdaya ikan dapat dimanfaatkan secara lestari.

### ***Desain dan Struktur Model***

Desain dan struktur model dinamik dibangun menggunakan soft ware *Stella 5.0* terdiri dari 4 sub model yaitu : (1) sub model Produktivitas Plankton; (2) sub model Perikanan Pelagis; (3) sub model Perikanan Demersal dan (4) sub model Ekonomi dan Tol Laut. Sub model Produktivitas Plankton meliputi fitoplankton dan zooplankton yang dipengaruhi oleh parameter lingkungan dan pemangsa. Sub model ini menjelaskan dinamika kelimpahan fitoplankton dan zooplankton. Pengaruh pertumbuhan dan pemangsa sangat menentukan peningkatan dan pengurangan kelimpahan plankton. Struktur sub model seperti ditunjukkan dengan diagram dalam Gambar 1.

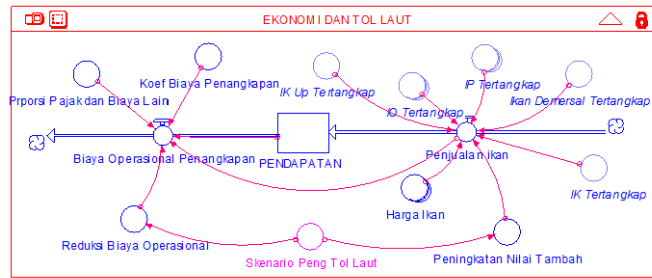


Gambar 1. Digram sub model Produktivitas Plankton

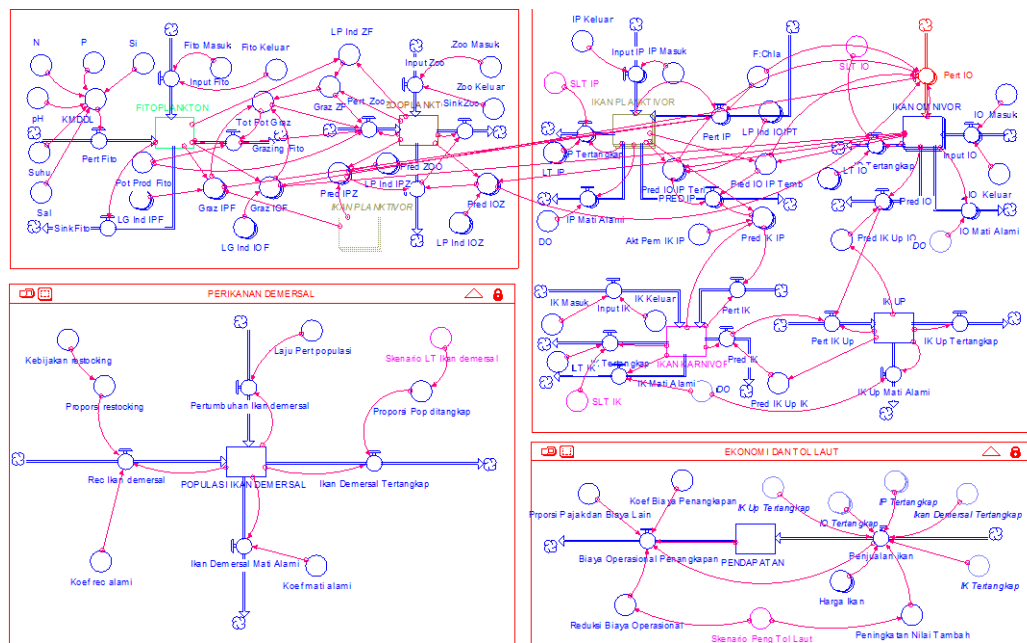
Sub model Perikanan Pelagis meliputi semua komponen ikan pelagis pada semua jenjang trofik level yang terdiri dari ikan planktivora, ikan omnivora, ikan karnivora termasuk ikan karnivora lebih tinggi. Ikan planktivora mengkonsumsi produksi plankton untuk pertumbuhan, ikan omnivora mengkonsumsi plankton dan ikan planktivora sedangkan ikan karnivora mengkonsumsi ikan planktivora maupun omnivora. Setiap kompartemen (stock) ikan dipengaruhi oleh inflow pertumbuhan dan ikan masuk sebagai faktor yang meningkatkan populasi sedangkan mati alami, penangkapan dan pemangsaan oleh ikan trofik di atasnya merupakan outflow yang menyebabkan berkurangnya biomassa populasi ikan. Struktur sub model seperti ditunjukkan dengan diagram dalam Gambar 2.

Sub model Perikanan Demersal meliputi populasi ikan demersal secara keseluruhan yang dipengaruhi oleh pertumbuhan dan rekrutmen (inflow) sedangkan penangkapan dan mati alami (outflow) mempengaruhi penurunan biomassa populasi ikan demersal. Besarnya quota tangkap mempengaruhi setiap stock baik ikan pelagis maupun ikan demersal. Struktur sub model seperti ditunjukkan dengan diagram dalam Gambar 3.





Gambar 4. Digram sub model Ekonomi



Gambar 5. Digram model dinamik terintegrasi (biologi-ekologi dan ekonomi) berbasis trofik level

### ***Persamaan Model (Model Equation)***

Salah satu faktor kunci yang sangat penting dalam pembuatan model dinamik menggunakan STELLA adalah formulasi persamaan. Kendala yang banyak ditemukan dalam penyusunan formula persamaan adalah menyusun bahasa yang dapat diterjemahkan oleh STELLA sehingga model dapat dijalankan sesuai dengan konsep dan design yang telah dibangun. Dalam kasus kajian ini telah dihasilkan berbagai macam persamaan matematik dan fungsi logic yang mengendalkan perilaku model seperti berikut ini :

$$\text{PENDAPATAN}(t) = \text{PENDAPATAN}(t - dt) + (\text{Penjualan\_ikan} - \text{Biaya\_Operasional\_Penangkapan}) * dt$$

$$\text{INIT PENDAPATAN} = 0$$

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Penjualan_ikan =
((Harga_Ikan[Planktivor]*(IP_Tertangkap[Teri]+IP_Tertangkap[Tembang]))+(Harga_Ikan[Omnivor]*
IO_Tertangkap[Pepetek]+IO_Tertangkap[Layang]+IO_Tertangkap[Kembung]))+(Harga_Ikan[karnivor]*IK_Tertangkap)+(Harga_Ikan[karnivor_up]*IK_Up_Tertangkap)+(Harga_Ikan[demersal]*Ikan_Demersal_Tertangkap))+(Peningkatan_Nilai_Tambah*((Harga_Ikan[Planktivor]*(IP_Tertangkap[Teri]+IP_Tertangkap[Tembang]))+(Harga_Ikan[Omnivor]*
IO_Tertangkap[Pepetek]+IO_Tertangkap[Layang]+IO_Tertangkap[Kembung]))+(Harga_Ikan[karnivor]*IK_Tertangkap)+(Harga_Ikan[karnivor_up]*IK_Up_Tertangkap)+(Harga_Ikan[demersal]*Ikan_Demersal_Tertangkap)))
Biaya_Operasional_Penangkapan = IF(PENDAPATAN>0) THEN
(Penjualan_ikan*Koef_Biaya_Penangkapan)+( Penjualan_ikan*Prporosi_Pajak_dan_Biaya_Lain)-
((Penjualan_ikan*Koef_Biaya_Penangkapan)+( Penjualan_ikan*Prporosi_Pajak_dan_Biaya_Lain)
* Reduksi_Biaya_Operasional) ELSE 0
Harga_Ikan[Planktivor] = 20000
Harga_Ikan[Omnivor] = 30000
Harga_Ikan[karnivor] = 50000
Harga_Ikan[karnivor_up] = 60000
Harga_Ikan[demersal] = 70000
Koef_Biaya_Penangkapan = (RANDOM(0.1,0.3,0.2))
Peningkatan_Nilai_Tambah = IF(Skenario_Peng_Tol_Laut=2) THEN RANDOM(0.2,0.35,0.25)
ELSE
IF(Skenario_Peng_Tol_Laut=3) THEN RANDOM(0.36,0.5,0.4) ELSE 0
Prporosi_Pajak_dan_Biaya_Lain = (RANDOM(0.05,0.1,0.075))
Reduksi_Biaya_Operasional = IF(Skenario_Peng_Tol_Laut=2) THEN RANDOM(0.1,0.2,0.15)
ELSE
IF(Skenario_Peng_Tol_Laut=3) THEN RANDOM(0.21,0.3,0.25) ELSE 0
Skenario_Peng_Tol_Laut = 3
POPULASI_IKAN_DEMERSAL(t) = POPULASI_IKAN_DEMERSAL(t - dt) +
(Rec_Ikan_demersal + Pertumbuhan_Ikan_demersal - Ikan_Demersal_Tertangkap -
Ikan_Demersal_Mati_Alami) * dt
INIT POPULASI_IKAN_DEMERSAL = 25000
Rec_Ikan_demersal =
(POPULASI_IKAN_DEMERSAL*Koef_rec_alami)+(Proporsi_restocking*(POPULASI_IKAN_DEMERSAL*Koef_rec_alami))
Pertumbuhan_Ikan_demersal = POPULASI_IKAN_DEMERSAL*Laju_Pert_populasi
Ikan_Demersal_Tertangkap = POPULASI_IKAN_DEMERSAL*(Proporsi_Pop_ditangkap/12)
Ikan_Demersal_Mati_Alami = POPULASI_IKAN_DEMERSAL*Koef_mati_alami
Kebijakan_restocking = 3
Koef_mati_alami = (RANDOM(0.05,0.1,0.075))/12
Koef_rec_alami = (RANDOM(0.1,0.3,0.2))/12
Laju_Pert_populasi = (RANDOM(0.03,0.05,0.04))
Proporsi_Pop_ditangkap = IF (Skenario_LT_Ikan_demersal=3) THEN (RANDOM(0.5,0.6,0.55))
ELSE
IF (Skenario_LT_Ikan_demersal=2) THEN (RANDOM(0.61,0.7,0.65)) ELSE
(RANDOM(0.71,0.8,0.75))
Proporsi_restocking = IF (Kebijakan_restocking=1) THEN (RANDOM(0.01,0.03,0.02)) ELSE
IF (Kebijakan_restocking=2) THEN (RANDOM(0.031,0.05,0.04)) ELSE
(RANDOM(0.051,0.07,0.06))
Skenario_LT_Ikan_demersal = 3
IK_UP(t) = IK_UP(t - dt) + (Pert_IK_Up - IK_Up_Tertangkap - IK_Up_Mati_Alami) * dt
INIT IK_UP = 250

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$Pert\_IK\_Up = ((IK\_UP * 0.00833) + ((Pred\_IO[Pepetek] + Pred\_IO[Layang] + Pred\_IO[Kembung]) * 0.1) + (Pred\_IK * 0.1))$   
 $IK\_Up\_Tertangkap = IK\_UP * (RANDOM(0.5, 0.7, 0.5))$   
 $IK\_Up\_Mati\_Alami = IF DO < 2 THEN IK\_UP ELSE 0.1 * IK\_Up$   
 $IKAN\_KARNIVOR(t) = IKAN\_KARNIVOR(t - dt) + (Pert\_IK + Input\_IK - IK\_Tertangkap - IK\_Mati\_Alami - Pred\_IK) * dt$   
 INIT IKAN\\_KARNIVOR = 10084

DOCUMENT: Biomassa awal populasi ikan Karnivor (Kg)

$Pert\_IK = (IKAN\_KARNIVOR * 0.15) + (Pred\_IK\_IP[Teri] * 0.1) + ((Pred\_IK\_IP[Teri] * 0.1) * 1)$   
 DOCUMENT: Pertumbuhan populasi Ikan Karnivor (Kg per hari)

$Input\_IK = IK\_Masuk - IK\_Keluar$   
 DOCUMENT: Tambahan populasi ikan omnivor (kg per hari)

$IK\_Tertangkap = IF(0.8 * IKAN\_KARNIVOR > SLT\_IK * LT\_IK * 60) THEN (SLT\_IK * LT\_IK * 60) ELSE (0.8 * IKAN\_KARNIVOR)$   
 DOCUMENT: Biomassa populasi Ikan Karnivor yang tertangkap (Kg per hari)

$IK\_Mati\_Alami = IF DO < 2 THEN IKAN\_KARNIVOR ELSE (0.1 * IKAN\_KARNIVOR)$   
 DOCUMENT: Biomassa populasi Ikan Karnivor yang mati alami (Kg per hari)

$Pred\_IK = (IF(0.5 * IKAN\_KARNIVOR > (Pred\_IK\_Up\_IK) * 30) THEN (Pred\_IK\_Up\_IK) * 30 ELSE (0.5 * IKAN\_KARNIVOR)) * 0.25$   
 DOCUMENT: Predasi ikan karnivor tingkat tinggi terhadap Ikan Karnivor (kg per hari)

$IKAN\_OMNIVOR[Pepetek](t) = IKAN\_OMNIVOR[Pepetek](t - dt) + (Input\_IO[Pepetek] + Pert\_IO[Pepetek] - IO\_Tertangkap[Pepetek] - IO\_Mati\_Alami[Pepetek] - Pred\_IO[Pepetek]) * dt$   
 INIT IKAN\\_OMNIVOR[Pepetek] = 889073  
 $IKAN\_OMNIVOR[Layang](t) = IKAN\_OMNIVOR[Layang](t - dt) + (Input\_IO[Layang] + Pert\_IO[Layang] - IO\_Tertangkap[Layang] - IO\_Mati\_Alami[Layang] - Pred\_IO[Layang]) * dt$   
 INIT IKAN\\_OMNIVOR[Layang] = 463271  
 $IKAN\_OMNIVOR[Kembung](t) = IKAN\_OMNIVOR[Kembung](t - dt) + (Input\_IO[Kembung] + Pert\_IO[Kembung] - IO\_Tertangkap[Kembung] - IO\_Mati\_Alami[Kembung] - Pred\_IO[Kembung]) * dt$   
 INIT IKAN\\_OMNIVOR[Kembung] = 49817  
 $Input\_IO[Jenis\_Ikan\_Omnivor] = IO\_Masuk - IO\_Keluar$   
 DOCUMENT: Tambahan populasi Ikan Omnivor (Kg per hari)

$Pert\_IO[Pepetek] = (IKAN\_OMNIVOR[Pepetek] * 0.1) + ((Graz\_IOF[Pepetek] / F:Chla * 0.1 * 30)) + ((Pred\_IOZ[Pepetek] * 0.1 * 30)) + (Pred\_IO\_IP\_Teri[Pepetek] * 0.1 * 30) + (0 * Pred\_IO\_IP\_Temb)$   
 $Pert\_IO[Layang] = (IKAN\_OMNIVOR[Layang] * 0.1) + ((Graz\_IOF[Layang] / F:Chla * 0.1 * 30)) + ((Pred\_IOZ[Layang] * 0.1 * 30)) + ((Pred\_IO\_IP\_Teri[Layang] + Pred\_IO\_IP\_Temb) * 0.1 * 30)$   
 $Pert\_IO[Kembung] = (IKAN\_OMNIVOR[Kembung] * 0.1) + ((Graz\_IOF[Kembung] / F:Chla * 0.1 * 30)) + ((Pred\_IOZ[Kembung] * 0.1 * 30)) + ((Pred\_IO\_IP\_Teri[Kembung] * 0.1 * 30)) + (0 * Pred\_IO\_IP\_Temb)$   
 $IO\_Tertangkap[Pepetek] = IF(0.8 * IKAN\_OMNIVOR[Pepetek] > (SLT\_IO * LT\_IO[Pepetek] * 60)) THEN (SLT\_IO * LT\_IO[Pepetek] * 60) ELSE 0.8 * IKAN\_OMNIVOR[Pepetek]$   
 $IO\_Tertangkap[Layang] = IF(0.8 * IKAN\_OMNIVOR[Layang] > (SLT\_IO * LT\_IO[Layang] * 60)) THEN (SLT\_IO * LT\_IO[Layang] * 60) ELSE 0.8 * IKAN\_OMNIVOR[Layang]$

$IO\_Tertangkap[Kembung] = IF(0.8 * IKAN\_OMNIVOR[Kembung] > (SLT\_IO * LT\_IO[Kembung] * 60)) THEN (SLT\_IO * LT\_IO[Kembung] * 60) ELSE 0.8 * IKAN\_OMNIVOR[Kembung]$   
 $IO\_Mati\_Alami[Jenis\_Ikan\_Omnivor] = IF(DO < 2) THEN IKAN\_OMNIVOR[Jenis\_Ikan\_Omnivor] ELSE 0.1 * IKAN\_OMNIVOR[Jenis\_Ikan\_Omnivor]$   
 DOCUMENT: Populasi Ikan Omnivor yang mati alami (Kg per hari)

$Pred\_IO[Jenis\_Ikan\_Omnivor] = (IF (IKAN\_OMNIVOR[Jenis\_Ikan\_Omnivor] * 0.5 > Pred\_IK\_Up\_IO * 30) THEN Pred\_IK\_Up\_IO * 30 ELSE 0.5 * IKAN\_OMNIVOR[Jenis\_Ikan\_Omnivor]) * 0.25$   
 DOCUMENT: Laju predasi ikan karnivor (kg per hari)

$IKAN\_PLANKTIVOR[Teri](t) = IKAN\_PLANKTIVOR[Teri](t - dt) + (Input\_IP[Teri] + Pert\_IP[Teri] - IP\_Tertangkap[Teri] - IP\_Mati\_Alami[Teri] - PRED\_IP[Teri]) * dt$   
 $INIT\ IKAN\_PLANKTIVOR[Teri] = 799995$   
 $IKAN\_PLANKTIVOR[Tembang](t) = IKAN\_PLANKTIVOR[Tembang](t - dt) + (Input\_IP[Tembang] + Pert\_IP[Tembang] - IP\_Tertangkap[Tembang] - IP\_Mati\_Alami[Tembang] - PRED\_IP[Tembang]) * dt$   
 $INIT\ IKAN\_PLANKTIVOR[Tembang] = 745541$   
 $Input\_IP[Jenis\_Ikan\_Planktivor] = IP\_Masuk - IP\_Keluar$   
 DOCUMENT: Tambahan populasi ikan planktivor (Kg per hari)

$Pert\_IP[Teri] = (IKAN\_PLANKTIVOR[Teri] * 0.2) + ((Graz\_IPF[Teri] / F:Chla * 0.1) * 30) + (Pred\_IPZ[Teri] * 0.1 * 30)$   
 $Pert\_IP[Tembang] = (IKAN\_PLANKTIVOR[Tembang] * 0.15) + ((Graz\_IPF[Tembang] / F:Chla * 0.1) * 30) + (Pred\_IPZ[Tembang] * 0.1 * 30)$   
 $IP\_Tertangkap[Teri] = IF(0.8 * IKAN\_PLANKTIVOR[Teri] > (SLT\_IP * LT\_IP[Teri] * 60)) THEN (SLT\_IP * LT\_IP[Teri] * 60) ELSE 0.8 * IKAN\_PLANKTIVOR[Teri]$   
 $IP\_Tertangkap[Tembang] = IF(0.8 * IKAN\_PLANKTIVOR[Tembang] > (SLT\_IP * LT\_IP[Tembang] * 60)) THEN (SLT\_IP * LT\_IP[Tembang] * 60) ELSE 0.8 * IKAN\_PLANKTIVOR[Tembang]$   
 $IP\_Mati\_Alami[Jenis\_Ikan\_Planktivor] = IF(DO < 2) THEN (IKAN\_PLANKTIVOR[Jenis\_Ikan\_Planktivor]) ELSE (0.1 * IKAN\_PLANKTIVOR[Jenis\_Ikan\_Planktivor])$   
 DOCUMENT: Biomassa populasi ikan planktivor yang mati alami (Kg per hari)

$PRED\_IP[Teri] = ((Pred\_IO\_IP\_Teri[Pepetek] + Pred\_IO\_IP\_Teri[Layang] + Pred\_IO\_IP\_Teri[Kembung] + Pred\_IK\_IP[Teri]) + (0 * Pred\_IO\_IP\_Temb)) * 0.2$   
 $PRED\_IP[Tembang] = (Pred\_IO\_IP\_Temb + Pred\_IK\_IP[Tembang]) + ((Pred\_IO\_IP\_Teri[Pepetek] + Pred\_IO\_IP\_Teri[Layang] + Pred\_IO\_IP\_Teri[Kembung]) * 0) * 0.2$   
 $Akt\_Pem\_IK\_IP = IF (TIME = 6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 OR TIME = 7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115 OR TIME = 8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116 OR TIME = 9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117 OR TIME = 10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME = 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN 1 ELSE 0$   
 $DO = IF (TIME = 1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR TIME = 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109) THEN (5.36)$

ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62  
 OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (5.40)  
 ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63  
 OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (5.40)  
 ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64  
 OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (5.66)  
 ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65  
 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (5.72)  
 ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66  
 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (5.97)  
 ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67  
 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (5.55)  
 ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68  
 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (5.28)  
 ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69  
 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (5.13)  
 ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =  
 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (6.21)  
 ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =  
 71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (5.55)  
 ELSE (5.12)

DOCUMENT: Konsentrasi oksigen terlarut (ppm)

F:Chla = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR TIME =  
 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (17600)  
 ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62  
 OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (17800)  
 ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63  
 OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (17950)  
 ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64  
 OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (18200)  
 ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65  
 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (18350)  
 ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66  
 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (18625)  
 ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67  
 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (15965)  
 ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68  
 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (17800)  
 ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69  
 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (19538)  
 ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =  
 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (19812)  
 ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =  
 71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (18653)  
 ELSE (17450)

DOCUMENT: Jumlah Fitoplankton per mg Chlorofil-a per meter kubik air

IK\_Keluar = 10

DOCUMENT: Biomassa populasi ikan omnivor yang masuk ke dalam sistem (Kg per hari)

IK\_Masuk = 10

DOCUMENT: Biomassa populasi ikan omnivor yang masuk ke dalam sistem (Kg per hari)

IO\_Keluar = 10

DOCUMENT: Biomassa populasi ikan karnivor yang keluar dari sistem (Kg per hari)

IO\_Masuk = 10

DOCUMENT: Biomassa populasi ikan karnivor yang masuk ke dalam sistem (Kg per hari)

IP\_Keluar = 25

DOCUMENT: Populasi ikan pelagis yang keluar dari sistem (Kg per hari)

IP\_Masuk = 25

DOCUMENT: Populasi ikan pelagis yang masuk ke dalam sistem sistem (Kg per hari)

LP\_Ind\_IOIPT[Pepetek] = RANDOM (0,1,1)

LP\_Ind\_IOIPT[Layang] = RANDOM (0,3,1)

LP\_Ind\_IOIPT[Kembung] = RANDOM (0,5,2)

LT\_IK = IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (51.99)  
 ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (0.5)  
 ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (16.57)  
 ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (49.19)  
 ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME = 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (16.70)  
 ELSE 0

DOCUMENT: Laju tangkap ikan Karnivor (Kg per bulan per unit bagan)

LT\_IO[Pepetek] = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR TIME = 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (414.75)  
 ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62 OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (121.27)  
 ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63 OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (565.92)  
 ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64 OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (169.70)  
 ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (105.63)  
 ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (886.55)  
 ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (206.64)  
 ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (1307.67)  
 ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (7690.93)  
 ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME = 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (202.75)  
 ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME = 71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (16.32)  
 ELSE (166.18)

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LT_IO[Layang] = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49
OR TIME = 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (0)
ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62
OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (0)
ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63
OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (339)
ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64
OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (80)
ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65
OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (33)
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (107)
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (904)
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (499)
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (1889)
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (1647)
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (486)
ELSE (193)
LT_IO[Kembung] = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49
OR TIME = 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (25.10)
ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62
OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (0)
ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63
OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (1366)
ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64
OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (80)
ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65
OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (234.56)
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (50.27)
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (93.10)
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (54.70)
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (50.71)
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (20.88)
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (6.30)
ELSE (34.96)
LT_IP[Teri] = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR
TIME = 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (1261.17)
ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62
OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (1265.87)
ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63
OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (284.13)
ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64
OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (413.19)

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ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65
OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (636.15)
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (1105.19)
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (1298.51)
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (650.58)
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (829.62)
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (1087.93)
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (785.69)
ELSE (1048.58)
LT_IP[Tembang] = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49
OR TIME = 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (323.13)
ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62
OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (264.15)
ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63
OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (498.01)
ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64
OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (435.85)
ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65
OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (1978.74)
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (573.00)
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (1441.66)
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (601.47)
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (948.42)
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (1725.24)
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (578.70)
ELSE (574.19)
Pred_IK_IP[Teri] = IF ((IKAN_PLANKTIVOR[Teri]*0.1) > (RANDOM (0,9,4)*
((IKAN_KARNIVOR/0.03000)*0.00060)*30)) THEN (RANDOM (0,9,4)*
((IKAN_KARNIVOR/0.03000)*0.00060)*30*(Akt_Pem_IK_IP )) ELSE
(IKAN_PLANKTIVOR[Teri]*0.1*(Akt_Pem_IK_IP ))
Pred_IK_IP[Tembang] = IF ((IKAN_PLANKTIVOR[Tembang]*0.1) > (RANDOM (0,2,1)*
((IKAN_KARNIVOR/0.03000)*0.00561)*30)) THEN (RANDOM (0,2,1)*
((IKAN_KARNIVOR/0.03000)*0.00561)*30*(Akt_Pem_IK_IP )) ELSE
(IKAN_PLANKTIVOR[Tembang]*0.1*(Akt_Pem_IK_IP ))
Pred_IK_Up_IK = (IK_Up*RANDOM(0.1,0.20,0.10) )
Pred_IK_Up_IO = IK_Up*(RANDOM(0.1,0.2,0.1))*30
DOCUMENT: Laju predasi ikan karnivor tingkat tinggi terhadap ikan karnivor (Kg/hari)

Pred_IO_IP_Temb = IF ((IKAN_PLANKTIVOR[Tembang]*0.1) > ((RANDOM (0,1,1) *
(IKAN_OMNIVOR[Layang]
/0.01500)*0.00561)*30)) THEN ((RANDOM (0,1,1) * (IKAN_OMNIVOR[Layang]
/0.01500)*0.00561)*30) ELSE (IKAN_PLANKTIVOR[Tembang]*0.1)

```

$Pred\_IO\_IP\_Teri[Pepetek] = IF ((IKAN\_PLANKTIVOR[Teri]*0.2*0.4) >$   
 $(LP\_Ind\_IOIPT[Pepetek]* (IKAN\_OMNIVOR[Pepetek]$   
 $/0.00503)*0.00060)*30) THEN (LP\_Ind\_IOIPT[Pepetek]* ((IKAN\_OMNIVOR[Pepetek]$   
 $/0.00503)*0.00060)*30) ELSE (IKAN\_PLANKTIVOR[Teri]*0.2*0.4)$   
 $Pred\_IO\_IP\_Teri[Layang] = IF ((IKAN\_PLANKTIVOR[Teri]*0.2*0.4) >$   
 $(LP\_Ind\_IOIPT[Layang]* (IKAN\_OMNIVOR[Layang]$   
 $/0.01500)*0.00060)*30) THEN (LP\_Ind\_IOIPT[Layang]* ((IKAN\_OMNIVOR[Layang]$   
 $/0.01500)*0.00060)*30) ELSE (IKAN\_PLANKTIVOR[Teri]*0.2*0.4)$   
 $Pred\_IO\_IP\_Teri[Kembung] = IF ((IKAN\_PLANKTIVOR[Teri]*0.2*0.2) >$   
 $(LP\_Ind\_IOIPT[Kembung]* (IKAN\_OMNIVOR[Kembung]$   
 $/0.02500)*0.00060)*30) THEN (LP\_Ind\_IOIPT[Kembung]* ((IKAN\_OMNIVOR[Kembung]$   
 $/0.02503)*0.00060)*30) ELSE (IKAN\_PLANKTIVOR[Teri]*0.2*0.2)$

SLT\_IK = 2

DOCUMENT: 1

SLT\_IO = 1

DOCUMENT: Skenario Laju Tangkap Ikan Omnivor

SLT\_IP = 0.25

DOCUMENT: Skenario Laju Tangkap Ikan Pelagis

$FITOPLANKTON(t) = FITOPLANKTON(t - dt) + (Pert\_Fito + Input\_Fito - Grazing\_Fito -$   
 $Sink\_Fito) * dt$

INIT FITOPLANKTON = 1500

DOCUMENT: Kelimpahan Awal Fitoplankton (sel per liter)

Pert\_Fito = KMDDL

DOCUMENT: Laju Pertumbuhan Fitoplankton (Kg/hari)

Input\_Fito = Fito\_Masuk-Fito\_Keluar

DOCUMENT: Selisih Biomassa fitoplankton yang masuk dari luar sistem (Kg/hari)

$Grazing\_Fito = IF ((Tot\_Pot\_Graz > Pot\_Prod\_Fito) AND ((Tot\_Pot\_Graz - Pot\_Prod\_Fito) > (0.9*$   
 $FITOPLANKTON))) THEN$   
 $(0.9* FITOPLANKTON) ELSE IF ((Tot\_Pot\_Graz > Pot\_Prod\_Fito) AND ((Tot\_Pot\_Graz -$   
 $Pot\_Prod\_Fito) <= (0.9* FITOPLANKTON))) THEN (Tot\_Pot\_Graz - Pot\_Prod\_Fito) ELSE 0.1*$   
 $FITOPLANKTON$

DOCUMENT: Fraksi Fito yang dimangsa (Sel per liter per hari)

Sink\_Fito = FITOPLANKTON\*0.1

DOCUMENT: Laju pengendapan, termasuk fraksi fitoplankton yang mati (sel/liter/hari)

$ZOOPLANKTON(t) = ZOOPLANKTON(t - dt) + (Input\_Zoo + Pert\_Zoo - Pred\_ZOO -$   
 $Sink\_Zoo) * dt$

INIT ZOOPLANKTON = 500

DOCUMENT: Kelimpahan Awal Zooplankton (individu per liter)

Input\_Zoo = Zoo\_Masuk-Zoo\_Keluar

$Pert\_Zoo = (ZOOPLANKTON*0.5)+(0.1*Graz\_ZF *(Grazing\_Fito / (Tot\_Pot\_Graz -$   
 $Pot\_Prod\_Fito)))$

Pred\_ZOO =  
 Pred\_IPZ[Teri]+Pred\_IPZ[Tembang]+Pred\_IOZ[Pepetek]+Pred\_IOZ[Layang]+Pred\_IOZ[Kembung]

Sink\_Zoo = (ZOOPLANKTON-Pred\_ZOO)\*0.790

Fito\_Keluar = 1000

DOCUMENT: Laju pengurangan fito yang keluar dari dalam sistem (Kg/hari)

Fito\_Masuk = 1000

DOCUMENT: Laju penambahan fito yang masuk dari luar sistem (Kg/hari)

Graz\_IOF[Pepetek] = IF ((FITOPLANKTON >750) AND  
 ((IKAN\_OMNIVOR[Pepetek]/0.00503\*(LG\_Ind\_IOF[Pepetek]/100))<  
 (0.4\*0.1\*0.9\*(FITOPLANKTON-750)))) THEN  
 (IKAN\_OMNIVOR[Pepetek]/0.00503\*(LG\_Ind\_IOF[Pepetek]/100)) ELSE IF  
 ((FITOPLANKTON >750) AND  
 ((IKAN\_OMNIVOR[Pepetek]/0.00503\*(LG\_Ind\_IOF[Pepetek]/100))>  
 (0.4\*0.1\*0.9\*(FITOPLANKTON-750)))) THEN (0.4\*0.1\*0.9\*(FITOPLANKTON-750)) ELSE  
 0.01\* FITOPLANKTON

Graz\_IOF[Layang] = IF ((FITOPLANKTON >750) AND  
 ((IKAN\_OMNIVOR[Layang]/0.01500\*(LG\_Ind\_IOF[Layang]/100))<  
 (0.5\*0.1\*0.9\*(FITOPLANKTON-750)))) THEN  
 (IKAN\_OMNIVOR[Layang]/0.01500\*(LG\_Ind\_IOF[Layang]/100)) ELSE IF  
 ((FITOPLANKTON >750) AND  
 ((IKAN\_OMNIVOR[Layang]/0.01500\*(LG\_Ind\_IOF[Layang]/100))>  
 (0.5\*0.1\*0.9\*(FITOPLANKTON-750)))) THEN (0.5\*0.1\*0.9\*(FITOPLANKTON-750)) ELSE  
 0.01\* FITOPLANKTON

Graz\_IOF[Kembung] = IF ((FITOPLANKTON >750) AND  
 ((IKAN\_OMNIVOR[Kembung]/0.02500\*(LG\_Ind\_IOF[Kembung]/100))<  
 (0.1\*0.1\*0.9\*(FITOPLANKTON-750)))) THEN  
 (IKAN\_OMNIVOR[Kembung]/0.02500\*(LG\_Ind\_IOF[Kembung]/100)) ELSE IF  
 ((FITOPLANKTON >750) AND  
 ((IKAN\_OMNIVOR[Kembung]/0.02500\*(LG\_Ind\_IOF[Kembung]/100))>  
 (0.1\*0.1\*0.9\*(FITOPLANKTON-750)))) THEN (0.1\*0.1\*0.9\*(FITOPLANKTON-750)) ELSE  
 0.01\* FITOPLANKTON

Graz\_IPF[Teri] = IF ((FITOPLANKTON >750) AND  
 ((IKAN\_PLANKTIVOR[Teri]/0.0006\*(LG\_Ind\_IPF[Teri]/100)) <  
 (0.5\*0.2\*0.9\*(FITOPLANKTON-750)))) THEN  
 (IKAN\_PLANKTIVOR[Teri]/0.0006\*(LG\_Ind\_IPF[Teri]/100)) ELSE IF  
 ((FITOPLANKTON >750) AND  
 ((IKAN\_PLANKTIVOR[Teri]/0.0006\*(LG\_Ind\_IPF[Teri]/100)) >  
 (0.5\*0.2\*0.9\*(FITOPLANKTON-750)))) THEN (0.5\*0.2\*0.9\*(FITOPLANKTON-750)) ELSE  
 0.01\* FITOPLANKTON

Graz\_IPF[Tembang] = IF ((FITOPLANKTON >750) AND  
 ((IKAN\_PLANKTIVOR[Tembang]/0.00561\*(LG\_Ind\_IPF[Tembang]/100)) <  
 (0.5\*0.2\*0.9\*(FITOPLANKTON-750)))) THEN  
 (IKAN\_PLANKTIVOR[Tembang]/0.00561\*(LG\_Ind\_IPF[Tembang]/100)) ELSE IF  
 ((FITOPLANKTON >750) AND  
 ((IKAN\_PLANKTIVOR[Tembang]/0.00561\*(LG\_Ind\_IPF[Tembang]/100)) >  
 (0.5\*0.2\*0.9\*(FITOPLANKTON-750)))) THEN (0.5\*0.2\*0.9\*(FITOPLANKTON-750)) ELSE  
 0.01\* FITOPLANKTON

Graz\_ZF = LP\_Ind\_ZF\*ZOOPLANKTON

KMDDL = IF (((66.5926\*Suhu)+( 30.7069\*Sal)+( -29.0363\*pH)+( -  
 156.5903\*N)+( 46.8835\*P)+( 57927.7889\*Si)+( -2542.5614)) >

```

((67.7822*Suhu)+( 29.9394*Sal)+( -28.4932*pH)+ (-
158.3210*N)+( 51.0382*P)+( 57823.9851*Si)+( -2552.8699)) AND
((66.5926*Suhu)+( 30.7069*Sal)+( -29.0363*pH)+( -
156.5903*N)+( 46.8835*P)+( 57927.7889*Si)+( -2542.5614)) >
((68.6033*Suhu)+( 30.2725*Sal)+( -29.2255*pH)+ (-
159.4418*N)+( 52.7943*P)+( 58086.6472*Si)+( -2594.3576))) THEN
(RANDOM(637,1037,837)) ELSE
IF (((68.6033*Suhu)+( 30.2725*Sal)+( -29.2255*pH)+ (-
159.4418*N)+( 52.7943*P)+( 58086.6472*Si)+( -2594.3576)) >
((67.7822*Suhu)+( 29.9394*Sal)+( -28.4932*pH)+ (-
158.3210*N)+( 51.0382*P)+( 57823.9851*Si)+( -2552.8699)) AND
((68.6033*Suhu)+( 30.2725*Sal)+( -29.2255*pH)+ (-
159.4418*N)+( 52.7943*P)+( 58086.6472*Si)+( -2594.3576)) >
((66.5926*Suhu)+( 30.7069*Sal)+( -29.0363*pH)+( -
156.5903*N)+( 46.8835*P)+( 57927.7889*Si)+( -2542.5614))) THEN
(RANDOM(3333,4221,3777)) ELSE (RANDOM(1878,2273,2075))

```

DOCUMENT: Laju Pertumbuhan Fitoplankton

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LG_Ind_IOF[Pepetek] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME =
53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(163)+(RANDOM(-109,109))
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (210)+(RANDOM(-
138,138))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (220)+(RANDOM(-
125,125))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (233)+(RANDOM(-
102,102))
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (244)+(RANDOM(-
115,115))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (185)+(RANDOM(-
95,95))
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (198)+(RANDOM(-
126,126))
ELSE (209)+(RANDOM(-116,116))
LG_Ind_IOF[Layang] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME =
53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(919)+(RANDOM(-342,342))
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (767)+(RANDOM(-
269,269))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (677)+(RANDOM(-
274,274))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (944)+(RANDOM(-
340,340))

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ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (868)+(RANDOM(-
234,234))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (763)+(RANDOM(-
245,245))
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (919)+(RANDOM(-
269, 269))
ELSE (836)+(RANDOM(-299,299))
LG_Ind_IOF[Kembung] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME
= 53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(545)+(RANDOM(-191,191))
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (510)+(RANDOM(-
242,242))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (570)+(RANDOM(-
118,118))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (585)+(RANDOM(-
178,178))
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (635)+(RANDOM(-
178,178))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (550)+(RANDOM(-
170,170))
ELSE (566)+(RANDOM(-179,179))
LG_Ind_IPF[Teri] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53
OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(750)+(RANDOM(-350,350))
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (817)+(RANDOM(-
382,382))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (713)+(RANDOM(-
383,383))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (1733)+(RANDOM(-
609,609))
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (1289)+(RANDOM(-
463,463))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN
(1000)+(RANDOM(-381,381))
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN
(1680)+(RANDOM(-411,411))
ELSE (1147)+(RANDOM(-586,586))
LG_Ind_IPF[Tembang] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME
= 53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(2555)+(RANDOM(-931,931))

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ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (2393)+(RANDOM(-
794,794))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (2095)+(RANDOM(-
581,581))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (1838)+(RANDOM(-
408,408))
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (1305)+(RANDOM(-
305,305))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN
(1648)+(RANDOM(-589,589))
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN
(1550)+(RANDOM(-376,376))
ELSE (1912)+(RANDOM(-730,730))
LP_Ind_IOZ[Pepetek] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME =
53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(357)+(RANDOM(-129,129))
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (347)+(RANDOM(-
122,122))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (365)+(RANDOM(-
198,198))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (378)+(RANDOM(-
129,129))
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (433)+(RANDOM(-
184,184))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (498)+(RANDOM(-
204,204))
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (410)+(RANDOM(-
197,197))
ELSE (401)+(RANDOM(-176,176))
LP_Ind_IOZ[Layang] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME =
53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(860)+(RANDOM(-328,328))
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (766)+(RANDOM(-
261,261))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (1088)+(RANDOM(-
353,353))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (960)+(RANDOM(-
306,306))

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ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (835)+(RANDOM(-
256,256))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (812)+(RANDOM(-
354,354))
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (760)+(RANDOM(-
304,304))
ELSE (868)+(RANDOM(-324,324))
LP_Ind_IOZ[Kembung] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME
= 53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(1090)+(RANDOM(-391,391))
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (1195)+(RANDOM(-
347,347))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (1355)+(RANDOM(-
343,343))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (1170)+(RANDOM(-
541,541))
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (1210)+(RANDOM(-
416,416))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN
(1025)+(RANDOM(-271,271))
ELSE (1174)+(RANDOM(-391,391))
LP_Ind_IPZ[Teri] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53
OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(357)+(RANDOM(-129,129))
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (347)+(RANDOM(-
122,122))
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (365)+(RANDOM(-
198,198))
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (378)+(RANDOM(-
129,129))
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (433)+(RANDOM(-
184,184))
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (498)+(RANDOM(-
204,204))
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (410)+(RANDOM(-
197,197))
ELSE (401)+(RANDOM(-176,176))
LP_Ind_IPZ[Tembang] = IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME
= 53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN
(780)+(RANDOM(-301,301))

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ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (960)+(RANDOM(-341,341))

ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (875)+(RANDOM(-246,246))

ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (663)+(RANDOM(-266,266))

ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (675)+(RANDOM(-215,215))

ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME = 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (848)+(RANDOM(-229,229))

ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME = 71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (855)+(RANDOM(-312,312))

ELSE (808)+(RANDOM(-289,289))

LP\_Ind\_ZF = IF((FITOPLANKTON >750) AND (-0.00023\*FITOPLANKTON)+(3.067\*(FITOPLANKTON/ZOOPLANKTON))>2.1887) THEN (-2.1887+(-0.00023\*FITOPLANKTON)+(3.067\*(FITOPLANKTON/ZOOPLANKTON))) ELSE 0

DOCUMENT: Laju grazing zooplankton terhadap fitoplankton (sel per liter per individu zoo per hari)

N = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR TIME = 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (0.963)

ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62 OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (0.922)

ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63 OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (0.608)

ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64 OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (0.309)

ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (0.045)

ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (0.08)

ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (0.422)

ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (0.334)

ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (0.246)

ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME = 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (0.466)

ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME = 71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (0.763)

ELSE (0.863)

DOCUMENT: Konsentrasi Nitrogen dalam air rata-rata antara permukaan sampai kedalaman 25 meter (ug/Kg air)

P = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR TIME = 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (0.423)

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ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62
OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (0.492)
ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63
OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (0.56)
ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64
OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (0.628)
ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65
OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (0.697)
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (0.553)
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (0.233)
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (0.175)
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (0.117)
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (0.227)
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (0.287)
ELSE (0.335)

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DOCUMENT: Konsentrasi Fosfat dalam air rata-rata antara permukaan sampai kedalaman 25 meter (ug/Kg air)

pH = 7

Pot\_Prod\_Fito = 5000

Pred\_IOZ[Pepetek] = IF ((IKAN\_OMNIVOR[Pepetek]/0.00503\*(LP\_Ind\_IOZ[Pepetek]/100))<  
(0.3\*0.6\*0.8\*( ZOOPLANKTON - 300))) THEN

(IKAN\_OMNIVOR[Pepetek]/0.00503\*(LP\_Ind\_IOZ[Pepetek]/100)) ELSE  
(0.3\*0.6\*0.8\*( ZOOPLANKTON - 300))

Pred\_IOZ[Layang] = IF ((IKAN\_OMNIVOR[Layang]/0.01500\*(LP\_Ind\_IOZ[Layang]/100))<  
(0.5\*0.6\*0.8\*( ZOOPLANKTON - 300))) THEN

(IKAN\_OMNIVOR[Layang]/0.01500\*(LP\_Ind\_IOZ[Layang]/100)) ELSE  
(0.5\*0.6\*0.8\*( ZOOPLANKTON - 300))

Pred\_IOZ[Kembung] = IF

((IKAN\_OMNIVOR[Kembung]/0.02500\*(LP\_Ind\_IOZ[Kembung]/100))<  
(0.2\*0.6\*0.8\*( ZOOPLANKTON - 300))) THEN

(IKAN\_OMNIVOR[Kembung]/0.02500\*(LP\_Ind\_IOZ[Kembung]/100)) ELSE  
(0.2\*0.6\*0.8\*( ZOOPLANKTON - 300))

Pred\_IPZ[Teri] = IF ((IKAN\_PLANKTIVOR[Teri]/0.0006\*(LP\_Ind\_IPZ[Teri]/100))<  
(0.2\*0.4\*0.8\*( ZOOPLANKTON - 300))) THEN

(IKAN\_PLANKTIVOR[Teri]/0.0006\*(LP\_Ind\_IPZ[Teri]/100)) ELSE  
(0.2\*0.4\*0.8\*( ZOOPLANKTON - 300))

Pred\_IPZ[Tembang] = IF

((IKAN\_PLANKTIVOR[Tembang]/0.00561\*(LP\_Ind\_IPZ[Tembang]/100))<  
(0.8\*0.4\*0.8\*( ZOOPLANKTON - 300))) THEN

(IKAN\_PLANKTIVOR[Tembang]/0.00561\*(LP\_Ind\_IPZ[Tembang]/100)) ELSE  
(0.8\*0.4\*0.8\*( ZOOPLANKTON - 300))

Sal = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR TIME = 61  
OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (29.6)

ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62  
OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (28.2)

ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63  
 OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (29.3)  
 ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64  
 OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (29.9)  
 ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65  
 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (31.3)  
 ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66  
 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (31.3)  
 ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67  
 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (30.6)  
 ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68  
 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (31.5)  
 ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69  
 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (32.8)  
 ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =  
 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (31.6)  
 ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =  
 71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (31.7)  
 ELSE (30.9)

DOCUMENT: Salinitas air rata-rata antara permukaan sampai kedalaman 25 meter (o/oo)

Si = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR TIME = 61  
 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (0.042)  
 ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62  
 OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (0.042)  
 ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63  
 OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (0.042)  
 ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64  
 OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (0.042)  
 ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65  
 OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (0.043)  
 ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66  
 OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (0.043)  
 ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67  
 OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (0.042)  
 ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68  
 OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (0.041)  
 ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69  
 OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (0.04)  
 ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =  
 70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (0.042)  
 ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =  
 71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (0.042)  
 ELSE (0.042)

DOCUMENT: Konsentrasi Silikat dalam air rata-rata antara permukaan sampai kedalaman 25 meter (ug/Kg air)

Suhu = IF (TIME=1 OR TIME = 13 OR TIME = 25 OR TIME = 37 OR TIME = 49 OR TIME =  
 61 OR TIME = 73 OR TIME = 85 OR TIME = 97 OR TIME = 109 ) THEN (28.0)  
 ELSE IF (TIME=2 OR TIME = 14 OR TIME = 26 OR TIME = 38 OR TIME = 50 OR TIME = 62  
 OR TIME = 74 OR TIME = 86 OR TIME = 98 OR TIME = 110 ) THEN (27.3)

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ELSE IF (TIME=3 OR TIME = 15 OR TIME = 27 OR TIME = 39 OR TIME = 51 OR TIME = 63
OR TIME = 75 OR TIME = 87 OR TIME = 99 OR TIME = 111 ) THEN (27.9)
ELSE IF (TIME=4 OR TIME = 16 OR TIME = 28 OR TIME = 40 OR TIME = 52 OR TIME = 64
OR TIME = 76 OR TIME = 88 OR TIME = 100 OR TIME = 112 ) THEN (28.2)
ELSE IF (TIME=5 OR TIME = 17 OR TIME = 29 OR TIME = 41 OR TIME = 53 OR TIME = 65
OR TIME = 77 OR TIME = 89 OR TIME = 101 OR TIME = 113 ) THEN (29.3)
ELSE IF (TIME=6 OR TIME = 18 OR TIME = 30 OR TIME = 42 OR TIME = 54 OR TIME = 66
OR TIME = 78 OR TIME = 90 OR TIME = 102 OR TIME = 114 ) THEN (27.5)
ELSE IF (TIME=7 OR TIME = 19 OR TIME = 31 OR TIME = 43 OR TIME = 55 OR TIME = 67
OR TIME = 79 OR TIME = 91 OR TIME = 103 OR TIME = 115) THEN (29.2)
ELSE IF (TIME=8 OR TIME = 20 OR TIME = 32 OR TIME = 44 OR TIME = 56 OR TIME = 68
OR TIME = 80 OR TIME = 92 OR TIME = 104 OR TIME = 116) THEN (29.2)
ELSE IF (TIME=9 OR TIME = 21 OR TIME = 33 OR TIME = 45 OR TIME = 57 OR TIME = 69
OR TIME = 81 OR TIME = 93 OR TIME = 105 OR TIME = 117) THEN (29.2)
ELSE IF (TIME=10 OR TIME = 22 OR TIME = 34 OR TIME = 46 OR TIME = 58 OR TIME =
70 OR TIME = 82 OR TIME = 94 OR TIME = 106 OR TIME = 118) THEN (29.7)
ELSE IF (TIME=11 OR TIME = 23 OR TIME = 35 OR TIME = 47 OR TIME = 59 OR TIME =
71 OR TIME = 83 OR TIME = 95 OR TIME = 107 OR TIME = 119) THEN (30.3)
ELSE (29.0)

```

DOCUMENT: Suhu air rata-rata antara permukaan sampai kedalaman 25 meter (oC)

Tot\_Pot\_Graz =

Graz\_ZF+Graz\_IPF[Teri]+Graz\_IPF[Tembang]+Graz\_IOF[Pepetek]+Graz\_IOF[Layang]+Graz\_IOF[Kembung]

Zoo\_Keluar = 1000

Zoo\_Masuk = 1000

### ***Simulasi Model Dinamik***

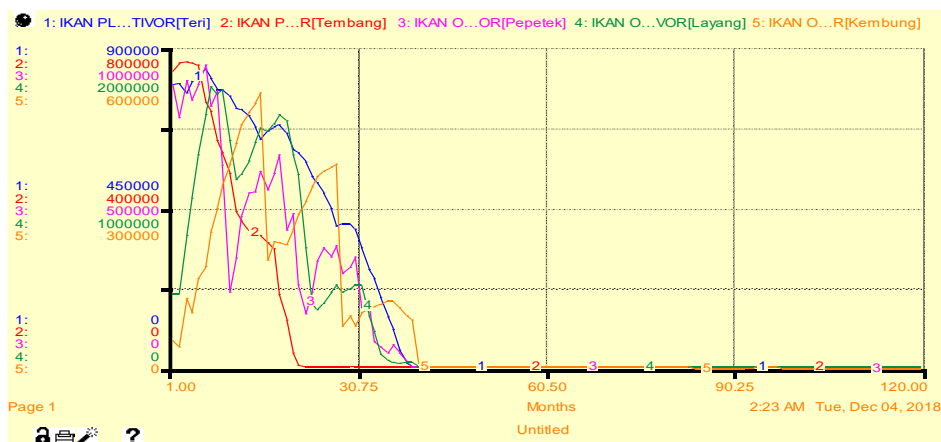
Skenario-skenario yang akan disimulasikan diantaranya :

- Laju tangkap berbeda ikan pelagis pada salah satu atau beberapa jenis ikan (menurut trofik levelnya) sebesar 25%, 50% dan 100% dari laju tangkap sekarang. Persentase laju tangkap ini disesuaikan dengan lama waktu penangkapan
- Penetapan laju tangkap ikan demersal sebesar 50-60%, 61-70% dan 71-80%
- Penerapan restocking dengan proporsi 1.0-3.0%. 3.1-5.0% dan 5.1-7.0% populasi ikan demersal
- Skenario pengembangan tol laut dalam kondisi eksisting (1), 2 pelabuhan pengumpul yaitu Barru dan Bantaeng (2) dan 4 pelabuhan pengumpul yaitu Bulukumba, bantaeng, Barru dan Pinrang (3)

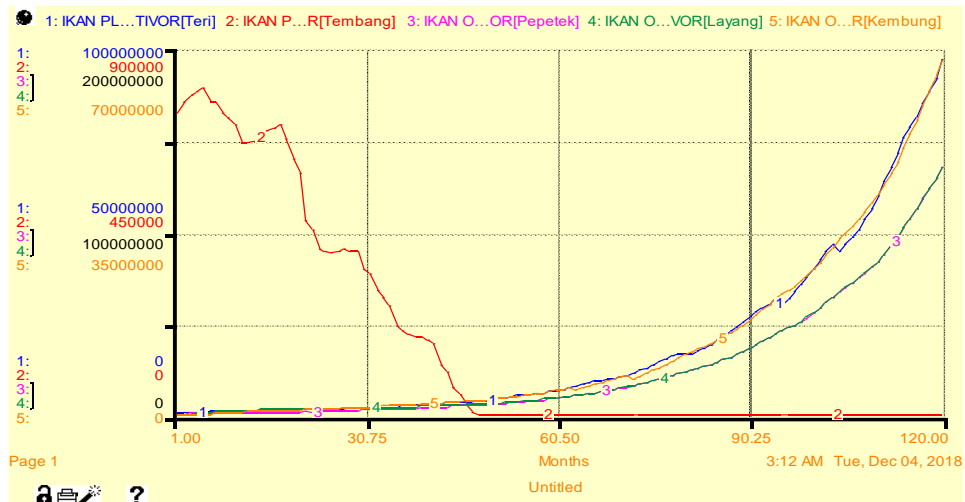
Keseluruhan skenario tersebut akan disimulasikan dalam rentang waktu 10 tahun (120 bulan) dengan interval atau time step setiap bulan.

Hasil simulasi model pada skenario laju tangkap ikan pelagis (planktivor, omnivor dan karnivor) seperti saat ini (100%) maka perubahan populasi ikan planktivor dan omnivor seperti ditunjukkan dalam Gambar 6a. Apabila laju tangkap dikurangi menjadi setengah (50%) dari laju tangkap saat ini pada semua trofik level maka maka penurunan populasi tidak secepat dengan pada skenario laju tangkap 100% (Gambar 6b). Selanjutnya apabila laju tangkap ikan pelagis dikurangi menjadi 25% dari laju tangkap saat ini maka terlihat adanya peningkatan populasi semua jenis ikan dari waktu ke waktu (Gambar 6c). Hal ini terjadi karena pengurangan populasi ikan dari penangkapan menjadi sangat rendah.

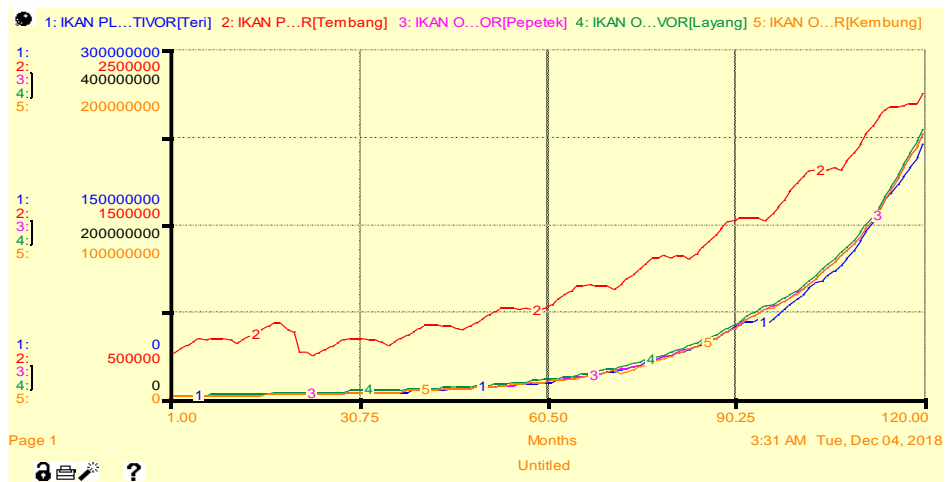
Perbedaan perubahan populasi ikan pada setiap skenario berimplikasi pada besarnya pendapatan yang diperoleh dari hasil penjualan ikan. Penangkapan berlebih diawal menyebabkan penurunan po[populasi sehingga dalam jangka panjang tidak menguntungkan dan populasi ikan tidak termanfaatkan secara berkelanjutan.



a



b



c

**Gambar 6. Perubahan biomassa populasi ikan planktivor dan omnivor selama 120 bulan berdasarkan hasil simulasi model pada skenario laju tangkap ikan pelagis 100% (a), 50% (b) dan 25% (c)**

Perbedaan skenario yang disimulasikan berimplikasi terhadap perbedaan pendapatan sebagai dampak dari perubahan populasi dan jumlah yang ditangkap disetiap trofik level ikan. Akumulasi pendapatan bersih (setelah dikurangi pengeluaran) setiap tahun pada 3 skenario yang disimulasikan dirangkum dalam Tabel 1.

Tabel 1. Akumulasi pendapatan (Rupiah) setiap tahun berdasarkan hasil simulasi model dinamik pada 3 skenario (pessimis, moderat dan optimis)

| Tahun | Skenario Pessimis | Skenario Moderat | Skenario Optimis |
|-------|-------------------|------------------|------------------|
| 1     | 73,971,109,954    | 62,396,833,814   | 87,631,171,860   |
| 2     | 153,891,418,352   | 157,107,881,637  | 220,696,641,739  |

|    |                 |                   |                    |
|----|-----------------|-------------------|--------------------|
| 3  | 214,832,948,650 | 277,315,544,204   | 413,810,652,499    |
| 4  | 230,473,597,773 | 442,495,760,935   | 735,189,181,259    |
| 5  | 232,143,741,678 | 669,795,505,387   | 1,272,649,532,841  |
| 6  | 233,607,505,348 | 1,026,448,777,322 | 2,273,871,839,710  |
| 7  | 234,820,590,165 | 1,646,043,748,465 | 4,203,109,020,232  |
| 8  | 236,015,450,284 | 2,694,427,350,548 | 8,085,261,537,384  |
| 9  | 237,073,254,813 | 4,271,937,331,172 | 15,406,301,781,976 |
| 10 | 238,003,697,041 | 7,081,897,493,536 | 30,418,843,459,685 |

## PENUTUP

Model dinamik yang dibuat dalam software STELLA mampu mengintegrasikan berbagai aspek dalam sistem pengelolaan perikanan termasuk integrasinya dengan progra tol laut di Selat Makassar. Untuk membangun model menggunakan STELLA diperlukan pengetahuan yang terdiri dari aspek-aspek : penyusunan konsep model, design dan struktur model serta penyusunan formula persamaan sehingga model yang dihasilkan dapat sesuai dengan yang diharapkan.

Berdasarkan hasil simulasi seperti dalam tabel 8 maka dapat dikatakan bahwa pengaruh simultan regulasi penangkapan (quota tangkap) dan pengembangan tol laut 2 unit (skenario moderat) di selat makassar dapat menaikkan lebih dari 6.84 triliun rupiah atau sekitar 57.03 milyar rupiah per bulan jika dibandingkan dengan membiarkan laju tangkap seperti saat ini dan tidak ada pengembangan tol laut (skenario pesimis). Dengan hitungan yang sama maka ketika skenario optimis dijalankan (quota tangkap dan pengembangan tol laut) dapat meningkatkan akumulasi pendapatan sebesar 30.18 triliun rupiah atau sekitar 251.51 milyar rupiah per bulan jika dibandingkan dengan membiarkan laju tangkap seperti saat ini dan tidak ada pengembangan tol laut (skenario pesimis). Jika dibagi rata ke 11 kabupaten maka skenario moderat meningkatkan sekitar 5.18 milyar rupiah per bulan per kabupaten dari skenario pesimis, sedangkan skenario optimis dapat meningkatkan sebesar 22.86 milyar rupiah per bulan per kabupaten dari skenario pesimis.

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